University of Arizona
College of Agriculture
Agricultural Experiment Station

THIRTY-FOURTH ANNUAL REPORT

For the Year Ended June 30, 1923

This Report constitutes Part III of the Annual Report of the Board of Regents of the University of Arizona, made in conformity to Article 4483, Title 42, Revised Statutes of Arizona, 1913.

PUBLISHED BY
University of Arizona
UNIVERSITY STATION
TUCSON, ARIZONA

ORGANIZATION

BOARD OF REGENTS

EX-OFFICIO MEMBERS

HIS EXCELLENCY, GEO W P HUNT, Governor of Arizona	Phoenix
HONORABLE CHARLES O CASE, State Superintendent of Public Instruction	Phoenix

APPOINTED MEMBERS

JOHN H CAMPBELL LL M	Tucson
CLEVE W VAN DYKE, Secretary	Miami
THEODORA MARSH, Treasurer	Nogales
EDMUND W WELLS	Prescott
ESTMER W HUDSON	Tempe
CHARLES M LAYTON	Safford
JOHN J CORRIGAN	Phoenix
EVERETT E ELLINWOOD, LL B, Chancellor	Phoenix

CLOYD HECK MARVIN, Ph D, LL D — President of the University

AGRICULTURAL EXPERIMENT STATION

JOHN J THORNBER, A M	Dean and Director
ALBERT E VINSON, Ph D	Agricultural Chemist
GEORGE E P SMITH, C E	Irrigation Engineer
RICHARD H WILLIAMS, Ph D	Animal Husbandman
WALTER S CUNNINGHAM, B S	Dairy Husbandman
CHARLES T VORHIES, Ph D	Entomologist
GEORGE E THOMPSON, B S A	Agronomist
FRANKLIN J CRIDER, M S	Horticulturist
WALKER E BRYAN, M S	Plant Breeder
JAMES G BROWN, M S	Plant Pathologist
ROYAL B THOMPSON, B S A	Poultry Husbandman
CLIFFORD N CATLIN, A M	Associate Agricultural Chemist
WILLIAM E CODE, C E	Assistant Irrigation Engineer
RALPH S HAWKINS, M S	Assistant Agronomist
ELIAS H PRESSLEY, B S	Assistant Plant Breeder
HAROLD C SCHWALEN, B S	Assistant Irrigation Engineer
*ERNEST B STANLEY, B S	Assistant Animal Husbandman
DAVID W ALBERT, B S	Assistant Horticulturist
STANLEY P CLARK, B S A	Assistant Agronomist
RICHARD N DAVIS, B S	Assistant Dairy Husbandman
ROBERT PENQUITE, B S A	Assistant Poultry Husbandman
FREDERICK GIBSON, B S	Assistant Plant Pathologist
ROBERT H BURNS, M S	Assistant Animal Husbandman
CHARLES A SMITH, B S	Assistant Animal Husbandman
ETHEL N IKENBERRY, B S	Secretary, College of Agriculture

EXPERIMENT STATION FARM FOREMEN

C J WOOD	Salt River Valley Farm, Mesa
T L STAPLEY	Tempe Date-Palm Orchard, Tempe
LESLIE BEATY, B S	Yuma Valley and Mesa Farms, Yuma
CARL CLARK, B S	Prescott Dry-Farm, Prescott
F G GRAY	Sulphur Spring Valley Dry-Farm, Cochise
J. R REED	University of Arizona Farm, Tucson

*On leave of absence

CONTENTS

ILLUSTRATIONS

TABLES

THIRTY-FOURTH ANNUAL REPORT

ADMINISTRATION

J. J. THORNBER

The growing demand for Experiment Station publications has exhausted the supply of many of these. To conserve as far as possible these publications, It is thought best no longer to mail them out as soon as, published to persons whose names appear on the general mailing list of the Agricultural Experiment Station, but rather to send to such persons from time to time announcements of new publications as they appear, and, following this to mail the publications to those persons who request them. This method is already in use by many experiment stations in the country. It is believed this plan will be a means of conserving these valuable publications which often are much in demand after the supply has been exhausted, and also that it will put them in the hands of the persons who are most interested in them, and who will derive the most good from them. Persons desiring to receive announcements of publications of the various Experiment Station bulletins, timely hints, and annual reports as they appear, should request that their names be placed on this Station mailing list.

DATE PALM WORK

The monthly inspection work in cooperation with the Federal Horticultural Board and the Arizona Commission of Agriculture and Horticulture relative to the eradication of Parlatoria scale on dates has been continued. No Parlatoria scale has been found in the Tempe Date Orchard since February, 1922, when a small colony was discovered on a date palm near the east end of the orchard. Particular care has been taken to clean the grounds and the palms of all decayed and dried fruit, which is believed will lessen the tendency for scale insects and fruit-rotting fungi to carry over from one year to the next. During the year, the palms made a good growth, and last fall they matured a full crop of fruit which was processed, packed, and sold readily.

Eradication of the Parlatoria scale at the small date orchard on the Yuma Valley Experiment Farm has not been as successful as had been expected. It has not been possible to have as frequent inspections at the Yuma Date Orchard as at the Tempe Date Orchard. Some re-infestation of the Parlatoria scale has also taken place. Doubtless this was due in part to the use of pollen from date trees that later were found to be infested with Parlatoria scale. Besides this, the scale is now known to be widely distributed on seedling date trees in the Yuma Valley, with the inevitable result that reinfestation of the trees at the Yuma Date Orchard has taken place. Attention is now being given to scale-eradication work in the Yuma Valley.

Good progress has been made in rooting date offshoots at all three stations, the Tempe Date Orchard, the Salt River Valley Experiment Farm, and the Yuma Valley Experiment Farm. It is believed that with additional work, the Experiment Station soon can recommend to date growers practical methods that will enable them to root a large percentage of their offshoots. This is a most important step toward the commercial development of the date industry in Arizona.

EGG-LAYING CONTEST

Beginning November 1, 1922, an egg-laying contest with 20 entries was started as a part of the experimental work of the Poultry Husbandry Section of the Experiment Station, The Experiment Station would scarcely be justified in conducting this work merely as an egg-laying contest. The work will be under careful observation and the results relating to various phases of poultry raising, such as methods of housing, feeding, laying qualities of different breeds and strains of fowls, suitability of our climate for commercial poultry work, and similar subjects that are of vital importance to poultrymen, will be published.

COŌPERATIVE WORK WITH BLACK ALKALI

The Experiment Station in cooperation with the Calumet & Arizona Mining Company, the El Paso and Southwestern, and Southern Pacific railroads, and certain interested farmers, conducted experiments on eight plots of land in the Casa Grande Valley, relative to neutralizing black alkali in lime soils with concentrated sulphuric acid. The Calumet & Arizona Mining Company donated the acid; the El Paso and Southwestern and Southern Pacific railroads supplied cars and transported the acid free of cost from the smelters at Douglas to Casa Grande, Arizona; and the farmers provided tanks to haul the acid from the cars to their respective farms. The work of applying the acid to the land was in charge of the Experiment Station, and the cropping experiments which followed were made in cooperation with the farmers. The practicability of this method of reclaiming black alkali soils will be given further study. The handling of concentrated sulphuric acid, is hazardous at best, and special means may have to be devised to make this work safe.

THE EXPERIMENT STATION FARMS

At the Prescott Dry-Farm, two new feedlots with mangers and watering troughs, were built. A part of the fence on the south and east sides of the farm was replaced with substantial posts and No. 9 woven-wire bull fencing. The orchard was fenced with rabbit-proof wire netting. With the better culture given, the orchard trees have made a very satisfactory growth and have borne a good crop of fruit. This farm has been improved very much during the past year, by cleaning up and leveling the grounds, filling old cellars and wells, and removing old fences and buildings that were no longer used.

Unfortunately, one of the team of mares broke a leg and had to be killed. This leaves the farm in need of one work animal during rush periods.

At the Sulphur Spring Valley Dry-Farm, a No. 1 Over-shot thresher was purchased at a cost of $196.65 for threshing beans, and similar crops; also a John Deere 3-wheel fodder cutter at a cost of $58. The latter is a very practical farm implement for harvesting corn or sorghum for fodder or silage.

At the Tempe Date Orchard, a Fuller and Jackson farm pump engine and pump jack with cylinder and brass rods, were purchased, also a 3,000-gallon galvanized water tank. These were to replace worn-out equipment. The small vacant area immediately east of the date packing house was planted to evergreen tamarisks. The large deciduous tamarisks growing about the grounds of the dwelling were removed, since they had become unsightly, and they were a source of seedling tamarisk trees which threatened to become a nuisance on uncultivated areas in the immediate vicinity.

About three acres of the date farm lying to the west of the date orchard were brought under cultivation to be planted next year to second-generation seedlings of the date breeding work begun some years ago by the Plant Breeding Section.

At the Salt River Valley Experiment Farm, a shed for experiments in drying grapes and raisin-making was built at a cost of about $75; also, a 90-ton silo of plastered-concrete construction at a cost of $400.

The following were also purchased for use at this farm: One John Deere manure and straw spreader; one John Deere border disc; one single-row Planet Jr. cultivator; one Twin City tractor complete; one 4-disc tractor plow; one self-feeder for grain thresher; one Curtis air-compressor with tank and pump; also, a fine Hampshire buck to replace the former one. During the year some necessary repairs were made on two cottages.

At the Yuma Mesa Experiment Farm, 1,600 split redwood grape stakes, and wire for grape trellises were bought for $206; also a small garage was built for about $100.

To facilitate the work in irrigating in the citrus orchard, vineyard, and other experiment plots, forty 8-inch concrete turnouts were installed.

On the Yuma Valley Experiment Farm, the following equipment was purchased: One P. and O. No. 20 corn and cotton planter with fertilizer attachments; one 12-inch oscillating fan; and one Fairbanks-Morse gasoline engine and No. 4 brass-lined pump to replace a worn-out one. A small house was built to cover the Fairbanks-Morse engine; also a poultry house and yard for the farm poultry flock at a cost of about $60. A good horse corral and shed were built to replace the old ones at a cost of about $110.

At the University Farm near Tucson, the following equipment was purchased: One Fresno; one turning plow; one 60-tooth harrow; one Champion forge; one lawn mower; one No. 103 wagon; one set Renfrew portable scales; one 3½-horsepower gas engine; and one DeLaval milking machine.

The following surplus registered stock raised by the University, or no longer needed, was sold to Arizona farmers: From the Salt River Valley Farm: Twelve Hampshire lambs, ewes and bucks, $180. From the University Farm: Three Jersey bull calves, $225; three Holstein bull calves, $400; one two-year-old Jersey bull, Oxford Nora's Fox, $100; one mature Holstein-Friesian bull, Changling Pontiac de Kol, $150; four Hereford cows and heifers, and one Hereford bull calf, $190; three Shropshire bucks, $42; three Hampshire lambs, $35; two Rambouillet bucks, $35; eighteen Duroc-Jersey boars and gilts, $449; five Poland China boars and gilts, $105.

The mature Jersey bull, Noble Topsy's Eminent Lad, became sterile and was sold to be slaughtered.

MISCELLANEOUS

In addition to the improvements already noted at the various Experiment Station farms, the following equipment was purchased for work in the Experiment Station laboratories at the University, or for instruction in the College of Agriculture: For agricultural chemistry work, one hydrograph, one surface-tension apparatus, one Haskins thermoelectric pyrometer and electric oven, total $253; for agronomy work, one cabinet for filing Riker mounts, one Torsion balance, maximum and minimum thermometers, and copper flasks, total $173; for dairy husbandry work, one autographic kodak, special 3-A, and one test table, total $230; for horticultural work, one knapsack sprayer and two dendographs, total $420; for irrigation investigations, one latest model Stevens water-level recorder, $174; for plant breeding, six dissecting microscopes, one hydrograph, No. 588, one Clipper cleaner, one condenser for Eagle 10-saw cotton gin, total $162; for plant pathology, five dissecting microscopes, one water bath, one centrifuge, total $135; for poultry husbandry, one Charters incubator, one Pioneer incubator, four Junior portable houses, one Standard feed battery, one steel feather barrel, one Standard Sol hot brooder, one coal stove brooder, and six regulators for Candee incubator, total $272; for the administration offices, two golden-oak, quartered bookcases, two Underwood typewriters, one stenographer's chair, total $195; for miscellaneous cabinets and furniture, $184; and one Ford touring car to replace worn-out car, $451.

RESIGNATIONS

Charles A. Smith, B.S., Instructor in Animal Husbandry, June 30, 1923, to become County Agricultural Agent in Cochise County.

R. H. Williams, Ph.D., Professor Animal Husbandry and Animal Husbandman, June 30, 1923.

G. E. Thompson, B.S., Professor of Agronomy and Agronomist, June 30, 1923.

LEAVE OF ABSENCE

Ernest B. Stanley, B.S., Assistant Professor of Animal Husbandry and Assistant Animal Husbandman, on leave of absence one year without salary.

APPOINTMENTS AND PROMOTIONS

J. J. Thornber, A.M., Dean, University of Arizona College of Agriculture, July 1, 1922.

Allen F. Kinnison, B.S., from half-time Assistant Professor of Horticulture and half-time Extension Horticulturist to full-time Extension Horticulturist, January 1, 1923.

Robert H. Burns, M.S., Assistant Professor of Animal Husbandry and Assistant Animal Husbandman, September 1, 1922.

Frederick Gibson, B.S., Instructor in Plant Pathology and Assistant Plant Pathologist, January 11, 1923.

Nelson McKaig, Jr., B.A., Graduate Assistant in Agricultural Chemistry, September 18, 1922.

Charles Augustus Smith, B.S., Instructor in Animal Husbandry and Assistant Animal Husbandman, September 1, 1922.

PUBLICATIONS

BULLETINS AND ANNUAL REPORTS

Thirty-second Annual Report by the Director and Members of the Staff, November, 1922. (6000)

Index to Volume VIII, bulletins 77-84, annual reports 1916-1917, and Timely Hints 111-135; Arizona Agricultural Experiment Station, March, 1923. - (2000)

No. 96, "Establishing a Commercial Vineyard in Arizona"—F. J. Crider, June, 1923. (9000)

TECHNICAL BULLETINS

No. I, "Life History of the Kangaroo Rat" (*Dipodomys spectabilis* Merriam)—Charles T. Vorhies and Walter P. Taylor, September 13, 1922. (3000)

No. 2, "Sunburn and Aphid Injury of Soybeans and Cowpeas"—Frederick Gibson, September 15, 1922. (3500)

No. 3, "Distribution of Arizona Wild Cotton" (*Thurberia thespesioides*) —Herbert C. Hanson, April 15, 1923. (3500)

No. 4, "The Efficiency oi Legume Inoculation for Arizona Soils"—R. S. Hawkins May 1, 1923.

TIMELY HINTS FOR FARMERS

No. 140, "The Pit Silo"—S. P. Clark, August 14, 1922. (6000)

No. 141, "Early Baart Wheat"—W. E. Bryan and C. J. Wood, October 15, 1922. (8000)

No. 142. "Black-Arm of Cotton: A Successful Method of Control"—J. G. Brown, October 20, 1922. (8000)

No. 143, "Bunt of Wheat"—J. G. Brown, April 15, 1923. (8000)

No. 144, "Growing Spinach in Arizona"—D. W. Albert, June, 1923. (8000)

TECHNICAL PAPERS

"A Method for the Determination of the Swelling Coefficient of Dry Soils When Wetted"—Vinson and Catlin, Journal of Agricultural Research, Vol. XXVI, October 6, 1923.

PROJECTS

AGRICULTURAL CHEMISTRY

A. E. Vinson, C. N. Catlin

Study of colloidal swelling of dry soils when wetted (Adams).

Influence of concomitant soil conditions on the toxicity of black alkali (Adams).

Gypsum treatment of black alkali at the University Farm (State).

Irrigating w?ters and soils (State).

AGRONOMY

G. E. Thompson, R. S. Hawkins, S. P. Clark

Continuation of studies at the Prescott Dry-Farm (State).

Continuation of studies at the Sulphur Spring Valley Dry-Farm (State).

Varietal and cultural tests of corn and the various sorghums (State).

Cooperative crop experiments (State).

Varietal and cultural tests of grains, forage crops, grasses, etc. (State).

Culture and management of winter and spring grains (State).

Culture and management of Egyptian cotton (State).

Study of the culture and varieties of legumes (State).

Deleterious effects of sorghums on the soil (State),

ANIMAL HUSBANDRY

R. H. Williams, E. B. Stanley, Chas. A. Smith

Skimmilk as a supplement to cracked hegari and alfalfa pasture for pigs (State).

Rhodes grass hay versus alfalfa hay for maintaining Hereford stock (State).

Comparison of cracked corn with cracked hegari; also a comparison of feeding cracked corn alone with cracked corn and 10 percent tankage to hogs (State).

Preparations of hegari for finishing yearling steers (State) (Hatch).

Study of vitamine deficiencies in hegari and how to finish pigs dwarfed on corn alone (State).

Fattening hogs on garbage(State).

Two methods of growing gilts and maintaining brood sows (State),

BOTANY

J. J. Thornber

Economic study of grasses and grass-like plants of Arizona (Hatch).

Poison plants of our grazing ranges (Hatch).

Range improvement through fencing (Hatch).

Trees and shrubs for ornamental planting (Hatch).

Study of jujube plants (Hatch).

Study of pistasch trees (Hatch).

Study of species of mulberries (Hatch).

Study of tamarisks, particularly *Tamarix articulata* (Hatch).

DAIRY HUSBANDRY

W. S. Cunningham, R. N. Davis

Milk substitutes for calves (State).

Mineral supplements to rations for dairy cattle (Hatch) (State).

ENTOMOLOGY

C. T. Vorhies

Study of grazing-range rodents (Adams).

Insect collection (State).

Thurberia bollworm (Adams).

HORTICULTURE

F. J. Crider, D. W. Albert

The olive (Hatch) (State).

Dates (Hatch) (State).

Study of conditions affecting the production of Irish potatoes in Arizona (Hatch) (State).

Study of cultural and storage methods of sweet potatoes in Arizona (Hatch) (State).

Study of varieties and cultural methods of citrus fruits (Hatch) (State).

Miscellaneous horticultural studies (State).

Spinach (State).

Study of water requirements of fruits (Hatch) (State).

Study of the effects of different methods of pruning upon deciduous fruits (Hatch) (State).

Walnut and pecan studies (Hatch) (State).

Study of the various conditions affecting commercial grape production in Arizona (Hatch) (State).

IRRIGATION

G. E. P. Smith, W. E. Code, H. C. Schwalen

Groundwater investigations (Adams) (State).

Relation of evaporation to the duty of water (Adams).

Pumping machinery (Adams) (State).

Water resources and irrigation in Cochise County (State).

PLANT BREEDING

W. E. Bryan, E. H. Pressley

Study of heritable characters in pure lines of alfalfa (Adams).

Selections to improve the Pima and Upland varieties of cotton (Adams) (State).

Breeding a high-yielding, heat-resisting field corn (State).

Study of the factors controlling milling and baking qualities of wheat (Adams) (State).

Selections to produce an edible field bean, which can be grown as a summer crop (Adams) (State).

PLANT PATHOLOGY

J. G. Brown, Frederick Gibson

Study of the effects of inoculation and spraying experiments on date rot (Adams).

Study of the influence of alkali on the susceptibility of cotton to black-arm and angular leaf-spot (Adams) (State).

Influence of alkali on the susceptibility of cotton to Texas root-rot (Adams) (State).

Miscellaneous plant disease studies (State).

POULTRY HUSBANDRY

R. B. Thompson, Robert Penquite

Foundation for experiment work (State).

Date of hatching (State).

Poultry-breeding contest (State).
Egg-laying contest (State).
Broiler production (State).

TABLE I.—SHOWING EXPERIMENT STATION EXPENDITURES BY FUNDS AND SCHEDULES FOR THE YEAR ENDED JUNE 30, 1923.

	State fund	State and Sales	Hatch fund	Adam® fund	Total
Salaries	$29,383 99	$10,799 52	$ 7,982 13	$12,397.87	$ 60,563 51
Wages	1,686 94	17 722 40	948 48	347.40	20,705 22
Student assistants	414 90				414.90
Stationery	229 02	128 13	235 73	191 59	784.47
Telephone and telegraph	68 08	104 96			173 04
Freight and express	344 33	382 20	414 96	86 99	1,228 48
Supplies	1,037 39	16 91	569 72	165 73	1,789 75
Travel	3,577 51	1,118 29	455 79	805 27	5,956.86
Printing	3,073 82		33 75		3,107 57
Motor vehicles	169 94	176 65	460 08		806,67
Small tools and appliances	351 98	1,181 83			1,533 81
Seeds and plants	148 14	968 33	359 41	76 62	1,552 50
Feed	316 25	1,667 23	2,198 47		4,181 95
Irrigation water and expense	93 56	2,516 64			2,610 20
Farm and garden supplies	79 95	1,841 05	37 70		1,958 70
Postage			306 10		306 10
Fuel			86 03		86 03
Insurance		65 34			65 34
Power and light		1,024 32			1,024 32
Medical service and supplies		332 42			332 42
Rent		10 50			10 50
Furniture and equipment	959 07	485 23	749 65	928 53	3,122 48
Buildings		1,897 10			1,897 10
Pipe, sewer and power line		365 63			365.63
Supplies and materials		90 25			90 25
Grounds		156 99			156.99
Machinery and tools		3,571 10			3,571.10
Livestock		720 88	162 00		882 88
Total	$41,934 87	$47,343 90	$15,000 00	$15,000 00	$119,278 77

Sales funds are returned to the State, and in addition to our State appropriation make up the total amount of moneys available far the use of the University of Arizona.

TABLE II.—SHOWING RECEIPTS FROM ALL SOURCES AND DISBURSEMENTS FOR ALL PURPOSES ON ACCOUNT OF THE COLLEGE OF AGRICULTURE FOR THE YEAR ENDED JUNE 30, 1923.

Fund	Balance	Receipts	Total	Disbursements	Balance
College of Agriculture	$	$ 29,363 80	$ 29,363 80	$ 29,363 80	$
Home Economics		12,078 66	12,078 66	12,078 66	
Agricultural Research		41,934 87	41,934 87	41,934 87	
University of Arizona Farm		18,993 93	18,993 93	18,993 93	
Experim't Farms					
Prescott Dry-Farm		4,831 57	4,831 57	4,831 57	
Salt River Valley Farm		20,188 05	20,188 05	20,188 05	
Sulphur Spring Valley Dry-Farm		3,168 81	3,168 81	3,168 81	
Tempe Date Palm Orchard		5,005 36	5,005 36	5,005 36	
Yuma Date Orchard Horticultural Station		13,042 79	13,042 79	13,042 79	
Hatch Sales	695 87	1,699 33	2,395 20	1,107 32	1,287 88
Adams		15,000 00	15,000 00	15,000 00	
Hatch		15,000 00	15,000 00	15,000 00	
Federal Smith-Lever and Federal Extension		32,761 23	32,761 23	32,761 23	
State Smith-Lever and State Extension		22,761 23	22,761 23	22,761 23	
Coöperative Agricultural Extension and County Extension	16,584 74	38,622 17	55,206 91	32,212 72	22,994 19
Totals	$17,280 61	$274,451 80	$291,732 41	$267,450 34	$24,282 07
Grand Totals	$291,732 41			$291,732 41	

AGRICULTURAL CHEMISTRY

C. N. CATLIN, A. E. VINSON

The activities of the Agricultural Chemistry Section during the year ended June 30, 1923, consisted of research work on the projects defined in former reports, of teaching, special reports, and miscellaneous analytical work for other sections, and for citizens of the State.

THE INFLUENCE OF CONCOMITANT SOIL CONDITIONS ON THE TOLERANCE OF CROPS FOR BLACK ALKALI

The pot-culture phases of this investigation have been in progress for 4 years, and this part of the project will be completed as soon as the results compiled are put in manuscript form.

During this year new treatments were used on a soil having a concentration of .2 percent sodium carbonate and on a soil from the Casa Grande Valley which contained .17 percent sodium carbonate. The latter was from land upon which sulphuric acid applications were made in the fall of 1922.

As in former years the black alkali content was half-neutralized, fully neutralized, and doubly neutralized in the different sets. Sulphuric and hydrochloric acids, sulphur Ajo slag (a by-product of the mining industry, having an approximate composition of three-fourths iron sulphate and one-fourth aluminum sulphate), citric acid, aluminum hydrate, aluminum palmitate, aluminum metal (pulverized), aluminum sulphide, and aluminum sulphate were used. The two latter chemicals were the only aluminum salts which had a neutralizing effect on the black alkali.

STUDY OF COLLOIDAL SWELLING OF DRY SOILS WHEN WETTED

In the previous annual report reference was made to the fact that the rate of swelling of soil when wetted differs greatly with different soils. During this year, a MacDougal auxograph was equipped with a rapidly moving drum and much new information was gathered on the rate" of swelling for soils in its relation to texture. A brief discussion of this phase was published in the Journal of Agricultural Research, Vol. XXVI, October 6, 1923.

The swelling curves of a number of widely scattered representative soil types secured from the United States Bureau of Soils were made.

Certain chemical treatments when applied to soils influence the form of the swelling curve of different soils in varying ways.

THE TEMPE DRAINAGE DITCH

In 1916, this ditch was opened to drain the alkali, water-logged area south of Tempe, and since that time samples of the drainage water have been collected and analyzed each month.

The very briny flow shown by the first analyses has gradually changed until the figure of total solids in more recent years has become fairly constant. It is quite significant that, as this decrease has taken place, the water has become characteristically black alkaline for the year 1922-1923.

In Table III the monthly variation in composition is recorded.

BLACK ALKALI STUDIES ON THE UNIVERSITY FARM

Gypsum and manure treatments on the University Farm have been successfully completed, and the results are in manuscript form for publication. Owing to certain changes at the University Farm the experiment has not been continued on a new tract of virgin, black alkali land as was contemplated,

THE TREATMENT OF BLACK ALKALI SOILS WITH SULPHURIC ACID

Experience has shown that leaching black alkali land is impracticable before chemical treatment which neutralizes the sodium carbonate and flocculates the soil.

The application of 100 tons of sulphuric acid in the Casa Grande Valley on eight different tracts in a preliminary way proved quite successful; certain factors entered into the experiment which prevented marked increases in crop production, except in a few cases.

Laboratory studies of soils from the treated tracts showed that in practically every case the percolation rate of water had been much increased, especially near the surface.

The sulphuric acid on coming in contact with the lime soil is neutralized, and as the acid does not penetrate far, the calcium sulphate formed is in a much finer, hence more readily soluble form than the gypsum ordinarily applied to alkaline lands. It has been found that calcium bicarbonate speeds up the percolation rate of a "tight" soil. This suggested the possibility that the percolation rate of a soil treated with sulphuric acid would be greater than of the same soil treated with gypsum. Percolation tests made in the laboratory showed this to be true. Where methods of application of sulphuric acid are followed, which tend to retain the CO_2 formed by the action of the acid on the lime soil in the water and soil, a double action results.

TABLE III.—MONTHLY VARIATION IN COMPOSITION OF WATER FROM TEMPE DRAINAGE DITCH (PARTS PER HUNDRED THOUSAND)

Date 1922-23	Total solids	Chlorides as NaCl	Hardness (perm.) $CaSO_4$	Hardness (temporary) $Ca(HCO_3)_2$	Alkalinity Na_2CO_3	Sulphates	Calcium	Magnesium
July	209 2	114 3		60 8	2 5	20 9	10 5	4 6
August	193 6	119 0	Neutral	48 0	Neutral	17 8	10 8	4 5
September	186 4	117 9		41 6	6 8	18 0	8 4	4 7
October	192 4	116 7		51 2	0 85	18 2	9 0	4 4
November	187 2	114 3		54 4	4 2	18 0	9 6	4 1
December	184 0	110 0		64 0	4 2	21 0	8 7	3 9
January	201 6	122 0	1 1	67 6		24 0	9 0	6 2
February	195 4	118 0		62 8	3 4	25 0	9 4	5 5
March*								
April*								
May	191 2	110 0		60 8	5 1	23 0	7 5	6 0
June	168 0	96 0		59 5	5 1	17 5	7 5	5 3

*Sample broken.

MISCELLANEOUS

An examination and report were made on the possible pollution of the San Pedro River by a powder plant above Benson, in April, 1923. Certain farmers using water from a canal heading on the San Pedro River above Benson called our attention to the possibility of damage resulting from drainage water coming from the powder plant.

The country surrounding and below the plant is highly calcareous, and the waters of the San Pedro Valley, both well and river waters, are, in general, alkaline in character. A comparison of the composition of the water of the river above the intake of the drainage and below it, showed no increase in acidity or alkali content. In order to detect toxic substances that might be present, wheat seedlings were grown in the various waters, and it was impossible to detect any difference between the several groups of plants.

During the last 20 years a large amount of data has been accumulated in regard to the character of the surface and groundwaters of Arizona from samples collected by members of the Experiment Station staff, and by citizens of the State. It has been found that where waters are causing alkali troubles with the soil, a greater number of samples has been collected, hence, the analyses received are not representative of the waters of the State as a whole. Therefore, a collection of representative samples has been started to connect together the data on hand for an early publication on the character of the waters of the entire State.

Many analyses of soils for alkali, determinations of the feeding value of certain feeding stuffs, and the fertilizing value of guanos and manures have been made during the year.

AGRONOMY

G. E. THOMPSON, R. S. HAWKINS, S. P. CLARK

INTRODUCTION

During the period covered by this report, July 1, 1922, to June 30, 1923, all the projects discussed in the Thirty-third Annual Report have been continued, except the one on Indian Agriculture. This project has been completed and a manuscript has been prepared for publication. One new project added this year, entitled Sorghum Investigations, is a study of the deleterious effects of sorghums on succeeding crops. The object of this project is to determine the cause of such effects and, if possible, to find a remedy. The project has been carried forward during the period of this report, and some very interesting data have been secured.

The office equipment has been improved very materially by the purchase of four large bulletin and general filing cabinets; also, shelving and metal containers have been installed in the basement seed room which will facilitate the preserving and handling the supply of various seeds on hand.

CONTINUATION OF STUDIES AT THE PRESCOTT DRY-FARM

CLIMATIC CONDITIONS

The crop season of 1923 was more unfavorable from the standpoint of rainfall than for several years past. The total rainfall for the year was less than usual, and the rain during the first half of the year came in small showers that soon evaporated. During this period the wind-movement was above normal in both duration and velocity. The growing season was very cool and the first killing frosts came 2 weeks earlier than usual.

SOIL-FERTILITY TESTS

That dry-farm soils, such as those at the Prescott Dry-Farm, respond readily to good soil management is evidenced by the results of the fertility tests begun in 1922. The use of 5 tons of barnyard manure increased the yield of Red Amber sorghum almost 2 tons per acre the first season. Owing to the unusually dry conditions no yield was obtained in 1923, although the use of barnyard manure did increase growth to some extent.

MAMMOTH RUSSIAN SUNFLOWERS

Several acres of sunflowers were planted after the summer rains began in July. The sunflowers made a heavier growth than did any other crop this season, and were not injured by early frosts nearly as much as were corn and sorghums.

Fig. 1.—Japanese Honeydrip sorghum grown for silage. Coöperative experiments with sorghum on Opie Ranch.

RED AMBER SORGHUM

Two strains of Red Amber sorghum were used; one, a local strain that has been grown without selection, and the other a selection made by a Kansas substation. This latter strain shows considerable promise for dry-farm conditions in the Prescott country. The plants were much more uniform in growth and in time of maturity than were those of the local, unselected strain. Seed selected from the 1923 crop will be used for future plantings at the Prescott Dry-Farm.

SUDAN GRASS

Three acres were sown to Sudan grass with the grain drill, on July 17, at the rate of 18 pounds of seed per acre. The crop was harvested on September 21, with a total yield of 2,607 pounds of excellent, cured hay. After the removal of the hay, this area was pastured by the work animals for several weeks with very little supplemental feed.

MISCELLANEOUS CROPS

Neither corn nor tepary beans made much growth this season because of lack of moisture, and the latter were further injured by jack rabbits. The tepary beans matured fairly well before frost; the corn did not. A small planting of kale made excellent growth after cool weather started in the fall and continued green and edible for stock until December 25.

Kale has some possibilities as a late fall crop when moisture conditions are favorable at that season.

CONTINUATION OF STUDIES AT THE SULPHUR SPRING VALLEY DRY-FARM

CLIMATIC CONDITIONS

The growing season from the beginning of the summer rains to the first killing frost in the fall averages about 110 days. Only quick-maturing crops can be grown with any likelihood of maturity, except in seasons when there is winter moisture sufficient for spring planting. Crops planted in the spring must be able to withstand the dry, windy weather of the spring months until summer rains begin. Late frosts often ruin crops planted in the spring.

LEGUME VARIETY TESTS

These tests were made on plots which received a limited amount of supplementary irrigation. Tepary beans easily out-yielded all other legumes in seed production, with Groit and Red Ripper cowpeas, second and third, respectively. Both the pink and pinto beans made very small yields. Weights were not kept on the yields for green manuring or for hay.

FORAGE CROPS

Red Amber sorghum occupied a larger acreage than did any other forage crop and made the largest yield per acre, but did not mature as well as did the Black Amber sorghum on account of having been planted too late in the summer. Sunflowers did not make as good growth as they did in 1921, when they out-yielded all other crops grown at this station. Both the sorghums and sunflowers matured and withstood drought better in rows 7 feet apart than in rows 3½ feet apart.

A STUDY OF THE CULTURE AND VARIETIES OF LEGUMES

Up to the present time practically all of the seed of leguminous soil-building crops has been shipped into the State at considerable expense, with the exception of alfalfa seed, which is grown locally. Most legumes tried have not been good seed-producers in this climate. Tepary beans, native to the Southwest, make a very satisfactory seed yield at the Sulphur Spring Valley Dry-Farm, and have proved to be a good summer green manure crop for the lower irrigated valleys of the State. Bengalia field peas produced at the rate of 8,875 pounds of green matter per acre at the Salt River Valley Experiment Farm in the spring of 1923. This crop also gave a very satisfactory yield of seed and is one of the most promising winter green manure crops that has been tried for this section of the State. *Vicia calcarata* is proving to be a heavier seed-producer than other vetches in the Yuma district. The seed of this variety was furnished the State Experiment Station at Yuma through the courtesy of the United States Government Experiment Station at Bard, California. This variety makes a very good growth of green matter, although it is not quite as heavy a producer in this respect as are the woolly podded, and purple vetches.

A planting of Pigeon peas, seed of which was obtained from Hawaii, made a very lank growth on the University Farm near Tucson, reaching a height of 8 feet. The plants did not mature a crop of seed, and perhaps would not in this climate. A hybrid cowpea also obtained from Hawaii made a fine growth and produced a good crop of well-matured seed. Further work is being done with this variety,

VARIETAL AND CULTURAL TESTS OF CORN AND SORGHUM

Varietal and cultural tests of corn and sorghum yields on the Salt River Valley Farm are given in the following table:

TABLE IV.—YIELDS OF CORN AND THE SORGHUMS ON THE SALT RIVER VALLEY FARM.

Variety	Plot	Crop	Acre yield
Hegari	W-41-44	Grain	2,343 pounds
Hegari	W-20-28½	Grain	2,716 pounds
Hegari	W-23-28½	Silage without heads	13,393 pounds
Hegari	W-28½-37	Silage	17,732 pounds
Avondale milo	E-58-60	Grain	4,424 pounds
Double Dwarf milo	W-67	Grain	3,703 pounds
Sumac	E-64-65	Grain	1,866 pounds
Sumac	E-64-65	Topped silage	14,907 pounds
White Yolo	E-62	Grain	1,966 pounds
White Yolo	E-62	Topped silage	7,090 pounds
Honey Drip	E-67	Silage	44,295 pounds
Mexican June corn	E-61-66	Silage	11,694 pounds
Mexican June corn	W-68-15-19 3-4-56		

It will be noted from the foregoing table that milo yielded the heaviest crop of grain; but because of "crookneck" and the inferior quality of milo fodder, hegari is more popular with farmers, Hegari remains green when the grain is mature, and a first-class, stover silage can be made from the stalks after they have been topped.

Sterile heads and partly sterile heads appeared in the hegari crop at Mesa in the fall of 1923 for the first time. Neither sulphur nor gypsum have influenced the growth of hegari on the Salt River Valley Experiment Farm this year.

The hand-selected hegari seed is very popular with seed houses and growers. This seed should be distributed under some kind of a pure seed contract, so that the supply can be increased and the quality maintained*

The new variety of sorghum, Yolo, has not proved to be a high-yielder on the Salt River Valley Farm.

Variety yields of forage crops on the University Farm were as follows:

Sunflowers	24,720 pounds silage per acre
Standard milo	14,700 pounds silage per acre
Egyptian milo	13,200 pounds silage per acre
Egyptian milo	16,500 pounds silage per acre
Dwarf milo	12,360 pounds silage per acre
Hegari	7,860 pounds silage per acre
Hegari	1,710 pounds silage per acre
Feterita, Kafir hybrid	13,860 pounds silage per acre
Feterita, Kafir hybrid	18,300 pounds silage per acre

CULTURE AND FIELD MANAGEMENT OF PIMA-EGYPTIAN COTTON

This project has been continued on the Salt River Valley Farm. The following data give acre-yields of seed-cotton secured from the fertilizer tests:

None	1,051 pounds
None	640 pounds
None	744 pounds
Barnyard manure, 5 tons	892 pounds
Check	730 pounds
Manure, 10 tons	940 pounds
Manure, 10 tons and Acid phosphate, 300 lbs	559 pounds
Acid phosphate, 250 lbs.	561 pounds
Check	773 pounds
Acid phosphate, 500 lbs.	649 pounds
Acid phosphate, 500 lbs. and Nitrate of soda, 200 lbs.	651 pounds
Acid phosphate, 500 lbs. and Cottonseed meal, 450 lbs.	443 pounds
Check	606 pounds
Acid phosphate, 500 lbs., nitrate of soda, 200 lbs.	422 pounds
Nitrate of soda, 200 lbs.	730 pounds
Nitrate of soda, 600 lbs.	1,026 pounds
Check	646 pounds
Cottonseed meal, 700 lbs.	629 pounds
Commercial cotton fertilizer, 200 lbs	1,011 pounds
None	1,320 pounds
None	1,002 pounds
None	1,564 pounds
None	1,329 pounds

A study of the cotton bolls produced on the fertility plots was made in order to determine what effect the different fertilizers had on maturity. The following table gives the results:

TABLE V.—EFFECT OF FERTILIZERS ON THE MATURITY OF COTTON.

Treatment	No plants	No. bolls			Average No. bolls per plant			Percent immature	Lbs. Acre yield
		Mature	Immat.	Total	Mature	Immat	Total		
Barnyard manure, 5 tons	78	1,571	459	2,030	20 14	5 88	26 02	22	892
Check	75	1,564	567	2,131	20 85	7 56	28 41	26	730
Barnyard manure, 10 tons	72	1,319	483	1,802	18 32	6 70	25 02	26	940
Manure 10 tons, acid phosphate 300 lbs	78	1,523	625	2,148	19 52	8 01	27 53	29	659
Acid phosphate, 250 lbs.	62	1,298	872	2,170	20 93	14 07	35 00	40	561
Check	85	901	859	1,760	10 60	10 10	20 70	49	773
Acid phosphate, 500 lbs.	52	1,120	579	1,699	21 53	11 13	32 66	34	649
Acid phosphate 500 lbs., nitrate of soda 200 lbs.	65	1,072	762	1,834	16 49	11 72	28 21	41	651
Acid phosphate 500 lbs., cottonseed meal 450 lbs.	47	629	1,055	1,684	13 38	22 44	36 82	62	443
Check	77	1,125	825	1,950	14 61	10 71	25 32	42	606
Acid phosphate 500 lbs., nitrate of soda 200 lbs.	83	1,125	565	1,690	13 55	6 80	20 35	33	422
Nitrate of soda 200 lbs.	90	1,561	586	2,147	17 34	6 51	23 85	27	730
Nitrate of soda 600 lbs.	63	1,195	590	1,785	18 96	9 36	29 32	33	1,026
Check	64	1,299	413	1,712	17 34	6 51	23 85	27	646
Cottonseed meal 700 lbs.	46	1,452	635	2,087	31 56	13 80	45 36	30	629
Commercial cotton fertilizer 200 lbs	90	1,635	614	2,249	18 17	6 82	24 99	27	1,011

TESTS FOR EARLINESS IN COTTON

TABLE VI.—RANK OF VARIETIES ACCORDING TO EARLINESS DETERMINED BY PERCENTAGE OF THE TOTAL YIELD OBTAINED AT THE FIRST PICKING SALT RIVER VALLEY EXPERIMENT FARM—1923

Rank	Variety	Yield per acre		Per cent total harvested at 1st picking
		1st picking	Total	
1	Lone Star	955	1,478	64 6
2	Mebane	975	1,51[illegible]	64 2
3	Acala	922	1,512	61 [illegible]
4	Deltatype Webber	895	1,557	[illegible] 5
5	Hartsville	087	1,881	52 [illegible]
6	Pima	545	1,213	45 0
7	Durango	400	1,088	36 8

TABLE VII.—RANK OF VARIETIES ACCORDING TO EARLINESS DETERMINED BY PERCENTAGE OF THE TOTAL YIELD OBTAINED AT THE FIRST PICKING YUMA EXPERIMENT FARM—1923

Rank	Variety	Yield per acre		Percent total harvested at 1st. picking
		1st. picking	Total	
1	Mebane	1,373	1,565	87 7
2	Lone Star	1,080	1,257	85 9
3	Deltatype Webber	895	1,106	80 9
4	Acala	1,098	1,464	75 0
5	Durango	952	1,272	74 8
6	Hartsville	976	1,529	63 8

TABLE VIII.—RANK OF VARIETIES ACCORDING TO YIELD OF LINT COTTON PER ACRE. SALT RIVER VALLEY EXPERIMENT FARM COTTON VARIETY TESTS—1923

Rank	Variety	Yield per acre		Percent lint
		Lint	Seed	
1	Lone Star	521	1,022	33 75
2	Mebane	491	934	34 46
3	Deltatype Webber	478	1,233	27 94
4	Acala	471	1,012	31 76
5	Hartsville	467	1,320	26 13
6	Durango	346	873	28 21
7	Pima	315	897	26 00

(Figures given are ginning weights made in February)

TABLE IX.—RANK OF VARIETIES ACCORDING TO YIELD OF LINT COTTON PER ACRE. YUMA EXPERIMENT FARM COTTON VARIETY TESTS—1923.

Rank	Variety	Yield per acre		Percent lint
		Lint	Seed	
1	Mebane	585	980	37 4
2	Acala	500	964	34 2
3	Hartsville	416	1,113	27 2
4	Lone Star	411	848	32 7
5	Durango	399	873	31 4
6	Deltatype Webber	258	849	23 3

TABLE X—RESULTS OF THE COTTON FERTILIZER TESTS AT THE YUMA EXPERIMENT STATION—1923.

Treatment	Yield seed-cotton per acre		Percent of total harvested at 1st picking
	1st. picking	Total	
Cottonseed meal, 100 lbs. per acre	1,555	1,696	92
Sulphur, 100 lbs. per acre	1,293	1,440	90
Complete (8-2-2), 300 lbs. per acre	1,281	1,391	89
Barnyard manure, 10 tons per acre	1,233	1,358	91
Add phosphate, 250 lbs. per acre	1,214	1,336	91
Sulphate of ammonia, 150 lbs. per acre	1,135	1,302	87
No treatment	1,152	1,293	89
Acid phosphate, 500 lbs. per acre	1,116	1,214	92
Muriate of potash, 200 lbs. per acre	1,020	1,140	89

CULTURE AND MANAGEMENT OF WINTER AND SPRING GRAINS

This work was conducted on the Salt River Valley Experiment Farm, the Ynma Valley Experiment Farm, and the University Farm at Tucson. The work included varietal tests for grain, varietal tests for hay, and fertility tests.

The small grain tests on the University Farm yielded as follows:

Kanred wheat	2,500 pounds per acre
Arizona No. 39	2,500 pounds per acre
Macaroni wheat	3,000 pounds per acre
Dicklow wheat	2,500 pounds per acre
Mariout barley	2,750 pounds per acre
Common row	2,500 pounds per acre
Trebi barley	2,250 pounds per acre

The results at the Yuma Valley Experiment Farm were as follows;

Federation wheat	3,375 pounds per acre
White Federation wheat	3,750 pounds per acre
Early Baart wheat	1,624 8 pounds per acre
Beldi barley	2,750 4 pounds per acre
Black Barbless barley	2,870 2 pounds per we
Mariout barley	924 6 pounds per acre

In the variety tests with small grains, yields were made on the Salt River Valley Experiment Farm as follows:

Early Baart wheat	2,190 pounds per acre
Macaroni wheat	1,554 pounds per acre
Sonora wheat	1,682 pounds per acre
Federation Hard wheat	1,521 pounds per acre
Australian White wheat	1,920 pounds per acre
California Club wheat	1,861 pounds per acre
Arizona Turkey wheat	1,799 pounds per acre
Marquis wheat	1,588 pounds per acre
Common 6-row barley	1,814 pounds per acre
Beardless barley	1,265 pounds per acre
Beldi barley	1,420 pounds per acre
Mariout barley	1,394 pounds per acre
Abbruzzes rye	544 pounds per acre

In the cereals for hay tests the following yields were obtained:

Early Baart wheat	5,689 pounds cured hay per acre
Red Texas oats	5,704 pounds cured hay per acre
Common 6-row barley	4,582 pounds cured hay per acre
Beardless barley	3,919 pounds cured hay per acre
Abbruzzes rye	3,173 pounds cured hay per acre

In the permanent wheat-fertility tests yields of threshed grain have been obtained as follows:

Wheat continuously, no treatment	1,756 lbs.
Wheat continuously, 5 tons barnyard manure annually	2,330 lbs.
Wheat continuously, 200 lbs. acid phosphate annually	1,772 lbs.
Wheat continuously, 236 lbs. nitrate of soda and 83 lbs. acid phosphate annually	2,428 lbs
Wheat once in two-year rotation including wheat, sorghums, cowpeas, corn	1,270 lbs.

VARIETAL AND CULTURAL TESTS OF GRAIN FORAGE CROPS, GRASSES, AND MISCELLANEOUS CROPS

Variety tests of millet on the Salt River Valley Experiment Farm yielded as follows:

Variety	Hay	Grain
Hog millet	5,250 pounds	625 pounds
Japanese millet	8,250 pounds	687 pounds
German millet	8,500 pounds	1,906 pound*
Common millet	6,000 pounds	1,312 pounds

Rhodes grass at the Yuma Valley Experiment Farm and also on the University Farm has made an excellent growth on alkaline soil, and is a promising crop for such soils.

COÖPERATIVE CROP EXPERIMENTS

Coöperative tests were conducted in all but two of the counties of the State in 1922. As a direct result of these demonstrations, many farmers are growing the introduced varieties in preference to the ones they formerly grew.

The following is a partial list of the harvesting yields from the coöperative tests.

In the northern part of the State, where the season is short, on account of the altitude, Minnesota No. 13 corn proved to be better adapted to those conditions than was any other variety. Because of this, the acreage is increasing annually.

Orange cane introduced into the northern part of the State in 1921, has proved to be a superior variety for syrup making. Previous to this introduction, Amber cane was used for syrup, yielding about 50 gallons per acre. Orange cane this year yielded 83⅛ gallons per acre.

Worthy and Kanota oats out-yielded all other varieties in the demonstration by 10 bushels per acre. These varieties will be planted in increase acreage next year.

Fig. 2.—Hegari grown as a grain crop. Coöperative experiments at Duncan, Arizona.

In northern Arizona Trebi and Beldi barley yielded 7 bushels per acre more than did any other variety. In Greenlee County the demonstration proved that Trebi barley was superior to all other varieties in 1922. As a result of this the cooperator ordered 200 pounds of pure seed for planting in 1923. His entire acreage will be of this variety in 1924, after which time his ranch will be a source of pure seed for the valley.

In two valleys of the State, Hard Federation wheat has proved to be a superior variety, and the cooperator has ordered pure seed for Increase planting.

In northern Arizona in the potato-growing district, maintaining soil fertility is a serious problem. Demonstrations were conducted to show the value of green manure. As a result several hundred pounds of field peas have been ordered for planting in 1924. Rye as a green manure crop in the demonstration increased the yield of potatoes 300 percent.

The results from small grain harvests for 1923 are as follows:

Greenlee County	Yield in lbs. per acre	*Yuma County*	Yield in lbs. per acre
Federation wheat	1,500	6-Row barley	2,375
Hard Federation wheat	2,500	Mariout barley	2,625
Arizona 39	1,750	Beldi barley	2,125
Early Baart wheat	1,375	Tennessee Winter barley	2,500
Federation White wheat	2,625	Trebi barley	2,125
Trebi barley	3,500	Speltz	1,375
		Red Turkey wheat	2,000
		Kanred wheat	1,250

The cooperator in Greenlee County has ordered Federation Hard wheat for increase planting next year.

The following table gives the results from the cotton variety tests. It will be noted that Acala gave the highest average yield and also the highest average lint percentage.

TABLE XI[illegible] YIELDS OF COTTON IN THE VARIETY TESTS.

Variety	Grower	Soil type	Planting date	No. Irr.	No. Culti.	First picking	Acre yield	Lint percentage
Acala	G. W. Birdno, Safford, Ariz.	Clay loam	May 5	1	4	10/5	1,[illegible]0	35
Hartsville	G. W. Birdno, Safford, Ariz.	Clay loam	[illegible] 5	1	4	1[illegible]	1,054	34
Deltatype Webber	G. W. Birdno, Safford, Ariz.	Clay loam	May 5	1	4	10/25	1,054	[illegible]
Durango	G. W. Birdno, Safford, Ariz.	Clay loam	[illegible]y 5	1	4	11/[illegible]	945	[illegible]5
Mebane	G. W. Birdno, Safford, Ariz.	Clay loam	[illegible]y 5	1	4	10/[illegible]0	1,124	33
Lone Star	G. W. Birdno, Safford, Ariz.	Clay loam	May 5	1	4	1[illegible]0	1,116	31
Pima	Harry Chandler, Mesa	Sandy loam	May 1[illegible]	4	5			24 [illegible]2
Acala	Harry Chandler, Mesa	Sandy loam	[illegible]y 1[illegible]	4	5	10/29	1,55[illegible] 7[illegible]	[illegible]
Hartsville	Harry Chandler, Mesa	Sandy loam	[illegible]y 16	4	5	11/15	2,219 2	35 21
Deltatype Webber	Harry Chandler, Mesa	[illegible] loam	May 1[illegible]	4	5	11/14	1,[illegible]02	[illegible]2 81
Durango No. 1[illegible]	Harry Chandler, Mesa	Sandy loam	May 1[illegible]	4	5	11/14	1,129	37 5
Mebane	Harry Chandler, Mesa	[illegible] loam	M[illegible] 1[illegible]	4	5	11/15	1,[illegible]30	30 4[illegible]
Lone Star	Harry Chandler, Mesa	[illegible] loam	[illegible]y 16	4	5	11/15	[illegible]75	[illegible] 6[illegible]
[illegible]	[illegible]olbt, Lowe, Phoe[illegible]	Clay loam	[illegible]y 1	4	8	10/15	2,[illegible]3 72	[illegible]

TABLE XI.—(Continued).

Variety	Grower	Soil type	Planting date	No. Irr.	No. Culti.	First picking	Acre yield	Lint percentage
Hartsville	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	1,869	29 09
Durango	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	1,792 5	33 33
Mebane	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	1,792 5	35 55
Pima	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	670 5	24 56
Deltatype Webber	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	1,733 25	29 78
Lone Star	Robt. Lowe, Phoenix	Clay loam	May 1	4	8	10/15	1,837 5	34 61
Field Hartsville	Robt. Lowe, Phoenix	Clay loam	May 1*	4	8	10/15		32.07
Pima	S. W. Cotton Co., Litchton	*	*	*	*	*	1,234	29 78
Deltatype Webber	S. W. Cotton Co., Litchton	*	*	*	*	*	1,929	28 88
Durango	S. W. Cotton Co., Litchton	*	*	*	*	*	1,728	32.64
Lone Star	S. W. Cotton Co., Litchton	*	*	*	*	*	1,998	38 1
Mebane	S. W. Cotton Co., Litchton	*	*	*	*	*	2,448	36 6
Hartsville	S. W. Cotton Co., Litchton	*		*	*	*	2,132	36 32
Acala	S. W. Cotton Co., Litchton	*	*	*	*	*	1,954	34.32

*No data available.

ANIMAL HUSBANDRY

R. H. WILLIAMS, R. H. BURNS, C. A. SMITH

INTRODUCTION

During the past year the range cattle business has continued to be unprofitable, owing to scarcity of forage during the winter and spring months, little demand for cattle, low prices, and limited capital. The range sheep business has been profitable due to high prices of wool and lambs, although winter feed on the desert was late and sparse. More early lambs were marketed from irrigated valleys and desert ranges than formerly at prices up to $16 per hundred in Kansas City, with a 33 percent cut at $12 per hundred. Wool sold as high as 56 cents per pound in Boston.

The experimental work conducted by the Animal Husbandry Section has consisted chiefly of investigations In feeding cattle and hogs. Additional studies have been made in the classification of range cattle, methods of docking lambs, and a study of me place and use of animals in typical conditions throughout the State.

THE FLOCKS AND HERDS

During the year the increase of the breeding stock on the University and the Salt River Valley farms has been of distinct merit, and much of this young stock will be retained. In addition to the natural increase of stock on the farms the following purchases have been made:

2 Rambouillet yearling ewes from W. S. Hansen of Utah.

2 Poland China gilts from C. W. Henry, Greeley, Colorado.

1 Poland China boar pig from J. H. Peak, Columbia, Missouri.

1 Duroc-Jersey boar pig from Weaver & Chittenden, Columbia, Missouri.

1 Hampshire buck from McLaughlin Bros., Virginia.

1 Shropshire buck bred by Purdue University.

The University Farm has also secured the loan of a fine Rambouillet yearling buck from the United States Sheep Experiment Station, Dubois, Idaho. Mr. William Gregg, San Simon, Arizona, exchanged with the University four Duroc-Jersey sows and one Poland China sow for market hogs. He also generously loaned the University Farm a good Duroc-Jersey boar.

CATTLE-FEEDING INVESTIGATIONS

More use is being made of irrigated lands for pasturing and feeding cattle. It is stated that 75,000 cattle were fed in the Salt River Valley during the past year.

STEER-FEEDING ON THE SALT RIVER VALLEY FARM

An experiment was conducted on the Salt River Valley Experiment Farm near Mesa to study the feed value of different preparations of hegari for finishing yearling steers. Eighty head of yearlings were selected for this experiment and divided into eight groups of 10 animals each. Four special problems were studied over a feeding period of 16 weeks.

Is a Silo Profitable in Cattle Feeding?—The results of this test indicate that larger gains were secured from feeding hegari silage, than from feeding hegari fodder, and that larger gains were secured from feeding hegari stover silage than from feeding hegari stover.

Will Heading Hegari Pay?—The steers receiving the forage with the grain were worth more at the end of the feeding test, and dressed a higher percentage, but they failed to give as large a net return as did the animals that were given the forage from which the grain had been removed. It is believed, however, that with a wider range in prices than obtained during the past year, heading the grain would not be profitable.

Does it Pay to Head, Thresh, and Grind Hegari Grain?—The gains in the four groups of steers were very similar, ranging from 1.95 to 2.18 pounds per head daily. In each case slightly larger gains were secured from feeding the ground grain, and less feed was required to produce these gains than was the case in feeding the whole grain. The added cost, however, of heading, drying, threshing, and grinding the grain was not warranted, since the lot of steers fed hegari silage made the cheapest gains and yielded the highest profit per animal.

Is Grain Feeeding Profitable with Hegari Silage?—The cost of 100 pounds gain increased in direct proportion to the amount of grain fed. The groups fed grain required less time to reach market finish, and were valued at a higher price at the end of the feeding test, but required a wider margin to pay for the expense of feeding. As a result of this test it seems advisable to limit the quantity of grain allowed yearling steers, except perhaps during the last few weeks that they are in the feedlots.

STEER-FEEDING ON THE PRESCOTT DRY-FARM

Forty yearling steers were fed over a period of 16 weeks: (1) To compare silage made from Papago sweet corn with silage made from Red Amber sorghum; (2) to study the effect of dehorning; and (3) to observe the results of continuous feeding of one kind of silage with that of changing from one kind of silage to another at frequent intervals. A ration of approximately 3 pounds of alfalfa hay, 2.77 pounds of cottonseed meal, and 35 pounds of silage was given each animal daily in the various lots throughout the test. The results are summarized as follows:

Feeding Silage from Papago Sweet Corn Versus Red Amber Sorghum—

1. Ninety-six pounds of Papago sweet corn silage were found to be equal to 100 pounds of Red Amber sorghum silage for making gains.

2. The cattle receiving Red Amber sorghum silage gained 95 percent as rapidly as did similar animals fed Papago sweet corn silage.

3, With Red Amber sorghum silage valued at $6 per ton, the test showed Papago sweet corn silage to be worth $6.24 per ton.

Feeding Horned Yearling Steers Versus Dehorned Yearling Steers—

1. During the first 8 weeks the dehorned steers gained only 80 percent as much as did the horned ones, due to the shock of dehorning.

2, The feed required to produce gains in live weight was 25.5 percent less with the horned cattle for the first 8 weeks of the test.

3, During the last 8 weeks the dehorned cattle gained 34.7 percent more than the horned stock, and required 39.1 percent less feed to make a unit gain in weight.

4. Dehorned cattle are more gentle than are horned stock in the feedlots. They ship better, shrink less, and do not bruise one another as much in the feedlot or in transit.

5. The dehorned cattle lost an average of 44 cents per head, and the horned animals lost $1.57 per head.

Continuous Feeding of One Kind of Silage Versus Changing Frequently the Kind of Silage—

1. Cattle do not make as rapid or as uniform gains, if the kind of silage given them is changed frequently.

2. Changing the kind of silage gives cattle a setback, for the steers thus fed gained 5 percent less than did similar animals fed continuously on Red Amber sorghum silage and 10 percent less than did the lot of steers receiving Papago sweet corn silage.

3. Changing frequently from one kind of silage to another increased the cost of gains 9 percent over the lot fed Papago sweet corn silage, and 5 percent over the cattle fed Red Amber sorghum silage.

RHODES GRASS HAY VERSUS ALFALFA HAY AS FEED FOR CATTLE

At the University Farm during the past year, Rhodes grass hay was compared with alfalfa hay when fed alone, and also when fed with a limited amount of silage, to cattle. These two tests continued over a period of 64 davs and gave results as indicated below. The first test included two lots of animals, each consisting of two Hereford heifers, 2 years old. The heifers in one lot were given all the alfalfa hay they would eat, and those in the other lot all the Rhodes grass hay they would eat. The heifers that were fed the alfalfa hay consumed an average of 15 pounds per head daily, and gained each 1.67 pounds daily. The heifers fed Rhodes grass hay consumed only 13 pounds per head daily, and gained each .39 pound daily.

The second test also included two lots, each consisting of two Hereford cows and two calves, the latter about 8 months old. The animals in one of these lots were fed collectively 40 pounds of silage, and, in addition, all the alfalfa hay they would eat daily. The animals in the other lot also were fed each day 40 pounds of silage, and, in addition all the Rhodes grass hay they would eat. The four animals (two cows and two calves) that were fed on the silage-alfalfa-hay ration consumed 27 pounds of alfalfa hay daily. In this lot the two cows gained an average of 2.33 pounds per head daily, and the two calves an average of 1.99 pounds per head daily.

The four animals (two cows and two calves) that were fed on the silage-Rhodes-grass hay ration consumed only 19 pounds of Rhodes grass hay daily. In this lot the two cows suffered a slight loss in weight, and the two calves made an average gain of only 1.21 pounds per head daily.

HOG-FEEDING INVESTIGATIONS

VITAMINES FOR PIGS

An investigation was made in maintaining two gilts on a restricted ration consisting of ground hegari and tankage, to study the effects of this feed on the breeding qualities of these animals. The gilts weighed 71 and 46 pounds, respectively, when placed on the ration and they were carried on this feed from September 14, 1921, until February 8, 1922. The gilts made normal growth and reached a large size. On July 1, 1922, one of the gilts weighed 400 pounds when 470 days old. At that time it was clearly apparent that she would not conceive, and she was turned in a grass lot with some other pigs where she became weak and died.

The other gilt was maintained until February 8, 1923, and weighed 469 pounds. She had also failed to conceive, and was turned out on alfalfa pasture in order to ascertain if green feed would correct the probable deficiency in her ration. This animal had become blind, and was apparently suffering from some kind of nutritional deficiency. After being on green feed for a time, she became healthy and thrifty, and a few months later conceived.

It is believed that a very small quantity of green feed would have corrected the deficiency in the ration given these gilts Stockmen should provide pigs kept in dry lots with some green feed.

GROUND YELLOW CORN VERSUS A MIXTURE OF GROUND YELLOW CORN AND 10 PERCENT TANKAGE

The comparison was made in the results obtained from feeding a ration of ground yellow corn alone from a self-feeder, with a mixture of 90 percent ground yellow corn and 10 percent tankage. This test covered a period of 20 weeks, but the pigs given the protein supplement were marketed at the end of 17 weeks. Lot I contained eight pigs fed ground yellow corn from a self-feeder; Lot II consisted of 7 pigs given a mixture of 90 percent ground yellow corn and 10 percent tankage. Each lot was given a mineral mixture. The ground yellow com was valued at $35 per ton and the tankage at $100 per ton.

The pigs in Lot II averaged 208 pounds at the end of 17 weeks and dressed 84 percent at that time. On the other hand, none of the pigs in Lot I at the end of 17 weeks weighed over 150 pounds and they were thin. In every way the tankage made an excellent supplement to the ground yellow corn. The pigs receiving this ration made large gains, reached an excellent market finish, and made an economical use of the feed. Corn alone was proved to be distinctly inferior as a feed, and it is doubtful whether any of the pigs fed the ration of ground yellow corn from the self-feeder would have reached a market finish, if they had been continued on that ration.

FATTENING HOGS ON GARBAGE

Two lots of purebred hogs were fed garbage alone during the early part of 1923. One lot consisted of seven purebred Duroc-Jerseys, all from the same litter. At the beginning of the experiment these pigs were 175 days old, and averaged 133 pounds per head. These animals were fed all the garbage they would eat until they reached market condition. Four of these pigs were marketed after "they had been in the feedlot 40 days, and the remaining three were sold 7 days later. These pigs gained at the rate of 2.12 pounds per head daily, and ate an average of 17.92 pounds of garbage per head daily. It required 844 pounds of garbage to produce 100 pounds gain in live weight. The garbage was valued at $6 per ton and the cost of 100 pounds gain was $2.53. These pigs averaged 227 pounds when marketed and were sold at $9.50 per hundred pounds. These animals dressed 74.61 percent. The net profit for the entire lot was $37.86. On this basis the garbage was worth $22.51 pef ton as feed.

At the same time another group of pigs was fed the same ration. This lot consisted of six purebred Poland China pigs 76 days old, and averaging 40 pounds per head. They were fed all the garbage they would eat until they were in market condition. The average daily gain for these pigs was 1.54 pounds per head, and they consumed daily 14.39 pounds of garbage. One hundred pounds gain required 936 pounds of garbage costing $2.81. These pigs were fed over a period of 106 days and were marketed at that time, averaging 203 pounds per head.

The net profit for the animals in this group was $58.13, valuing the garbage at $6 per ton. These pigs dressed 80 percent, and the value of the garbage as a feed during this experiment was found to be $19 23 per ton.

GROUND HEGARI VERSUS GROUND YELLOW CORN

Two lots of pigs were fed over a period of 21 weeks to compare ground hegari with ground yellow corn. Each of the lots contained seven pigs weighing an average of 56 pounds at the beginning of the test. The pigs in Lot I received a mixture of corn and tankage and gained an average of 1.28 pounds per head daily over a period of 17 weeks. The pigs in Lot II received a ration of ground hegari and tankage and gained an average of 1.90 pounds per head daily over a period of 20 weeks. More feed was consumed by the pigs in Lot I, but they required less feed to produce 100 pounds gain than did the pigs in Lot II. The cost of producing 100 pounds gain for the pigs in Lot I that were fed com valued at $35 per ton and tankage valued at $100 per ton was $8.45, while the cost of producing 100 pounds gain for the pigs in Lot II that were fed ground hegari valued at $30 per ton, and tankage at $100 per ton was $8 47. All the pigs in Lot I finished for market at the end of 17 weeks, while only three of the animals in Lot II reached a desirable finish at the end of 20 weeks.

The pigs fed corn and tankage all appeared to be healthy and vigorous. On the other hand, those in Lot II fed ground hegari and tankage showed some deficiency in their ration. The heaviest and fattest pig in this group became blind about May 1, and on May 4 had a nervous spasm. A second pig in this group had a nervous spasm on May 23, and the following day a third pig also showed these symptoms. At least two of the pigs were totally deaf and blind, and the others could see but poorly. Apparently these pigs were suffering from a deficiency of vitamines in their rations. The corn and tankage was a better ration for the pigs than was the hegari and tankage, both from the standpoints of the amount of the feed required to produce the same gains, and also from the health of the pigs. One hundred pounds gain required 408 pounds of corn and tankage, as compared with 458 pounds of hegari and tankage.

SEX AS A FACTOR IN FATTENING PIGS

Two lots of pigs containing 9 gilts and barrows in Lot I, and 4 boars in Lot II were used in this test. The animals were fed over a period of 77 days, and each lot was given cracked hegari from self-feeders, alfalfa pasture, and about 7 percent of skimmilk to 100 pounds of live weight. The pigs averaged 57 pounds when the test began. The mixed lot containing the gilts and barrows averaged 180 pounds at the end of the test, compared with an average of 185 pounds for the boars. The former gained an average of 1.60 pounds per head daily, and the latter 1,64 pounds. The boars consumed considerably more feed, and also required more feed to make the same gams, than did the mixed lot. The cost of gams was $5.42 per 100 pounds in Lot I, the gilts and barrows, and $6.36 per 100 pounds in Lot II, the boars. With a value of $10 per hundred pounds, the profit for each pig amounted to $5.65 in Lot I and $4.60 in Lot II.

A considerable difference was noted between the rates of gain in the gilts and barrows in the same lot. At the beginning of the test five Duroc-Jersey gilts averaged 95 days old, and had an average weight of 60 pounds; they gained in weight an average of 106 pounds, or 1.37 pounds per head daily. Two Duroc-Jersey gilts that were 100 days old and weighed 60 pounds each at the beginning of the test gained an average of 159 pounds, or 2.06 pounds per head daily. Three boars gained an average of 1.57 pounds per head daily. Although the boar pigs gained more than did the gilts and barrows, the barrows gained 10 percent more than did the boars. The barrows also gained 37 percent more than did the gilts. The boar pigs required 24 percent more cracked hegari and 2 percent more skimmilk to make the same gains than did the mixed lot containing gilts and barrows. The cost of gains was 17 percent higher with the boars than with the gilts and barrows, and the gilts and barrows returned 23 percent larger profits than did the boars.

TWO METHODS OF GROWING GILTS AND MAINTAINING BROOD SOWS

A study of the effect on Duroc-Jersey gilts of supplying them with abundant rations as compared with the effect of feeding less liberally has been continued. This study was begun in 1919 and all but one of the five original sows have been discarded. The three gilts that were well fed became barren and were sold to the butcher. A fourth sow that was not well fed when young also became barren and was sold. The only sow that has not been discarded was the smallest and thinnest one.

The study is being continued with one sow. On May 21, 1922, she farrowed 12 pigs and raised six. Again on November 24, 1922, she farrowed 10 pigs, eight of which she raised.

VARIOUS METHODS OF DOCKING LAMBS

This spring at the University Farm 23 lambs were docked with various instruments. The conditions under which this experiment was conducted were not ideal, in that there was a wide variation in the age and weight of the lambs, and in the time of docking. However, the results which were obtained as shown in the following table give some indication of the relative value of the various instruments used:

TABLE XII.—DATA ON LAMB-DOCKING EXPERIMENT.

No lambs	Method of docking	Birth weight	Weight when docked	Age when docked	Days to heal	Average Daily Gain		
						Birth to docking	1st 12 days after docking	Next 14 days
		Pounds	Pounds	Days		Pounds	Pounds	Pounds
9	Sharp knife	9 5	16 1	11 3	21 78	74	708	770
6	Very sharp	8 7	10 6	1 83	21 00	1 14	764	560
3	Pruning shears	10 3	20 5	12 3	20 00	88	847	809
3	Hot docking chisel	9 7	20 00	15 7	23 00	65	750	786
1	Docking shears	7 8	16 5	7 0	16 00	1 24	350*	571
1	Emasculator	9 8	13 6	4 0	19 00	95	78**	750

*13 Days **14 Days

DAIRY HUSBANDRY

W. S. CUNNINGHAM, R. N. DAVIS

The year 1922-23 was a prosperous one for the Arizona dairyman. Prices of dairy products were relatively high as compared with those of previous years, due largely to coöperative marketing in the Salt River Valley. The number of cows in the State increased somewhat as a result of heifers coming fresh, but many carloads of cows were sold and shipped to California. The large acreage planted to cotton, and the high price of feeding stuffs have prevented a very rapid development of the dairy industry.

ADVANCED REGISTRY TESTS

Several cows on the University Farm were tested officially, eight of which completed their records during the year. Table XIII shows the Advanced Registry records that were made.

TABLE XIII.—ADVANCED REGISTRY RECORDS COMPLETED AT THE UNIVERSITY OF ARIZONA DAIRY HERD IN 1922-1923,

Name	Age	Breed	Milk	Butterfat	Butter equivalent
	Years		Pounds	Pounds	Pounds
7-day record					
Miss Pell Pietertje	7	Holstein	601 1	16 937	21 171
305-day record:					
Miss Pell Pietertje	7	Holstein	19,022 1	648 72	810 90
Theresa Belle DeVries	6	Holstem	20,077 3	589 57	735 96
U. of A. Dichter Belle Liscomb	3	Holstem	8,724 9	303 71	379 63
365-day record:					
Moensje Jess Aspirante 2nd.	4	Holstein	16,848 7	563 84	704 80
Aldan's Oxford Nora	6	Jersey	9,143 0	551 48	648 80
259-day record:					
Arizona Butter Girl	6	Jersey	7,582 0	441 00	518 82
264-day record:					
Arizona Gipsy Draconis	5	Jersey	7,847 0	436 78	513 84

The Dairy Husbandry Section of the Experiment Station also has charge of Advanced Registry tests for breeders of dairy cattle in Arizona. Official tests were conducted on the farms of C. S. Conway, Safford, Charles Shouse, Mesa, B. Coman, Phoenix, Tempe Normal School, Tempe, Guy L. Jones, Glendale, and Miller Cattle Company, Buckeye, Arizona.

UNIVERSITY FARM HERD

The milk of each cow in the University herd was weighed dally, and a test for percentage of butterfat was made on 2 consecutive days in each month. Table XIV shows the production of the cows for the year ended June 30, 1923. This table includes all the cows in the University herd that were milked 9 or more months during the year. It will be noted that the Holstein-Friesian cows produced an average of 17,241.1 pounds of milk with 549.84 pounds of butterfat. This is a decided increase over that of the previous year. When it is considered that the average milk production for cows in the United States is about 3,600 pounds and the average butterfat production is about 160 pounds, per year, the yield by the University herd is noteworthy.

MINERAL SUPPLEMENTS IN RATIONS FOR DAIRY CATTLE; AND GREEN FEED VERSUS DRY FEED FOR DAIRY CATTLE

This project was conducted for a year to determine whether mineral supplements are necessary or desirable in rations of high-producing dairy cows where alfalfa hay is fed.

Sixteen cows were used and they were divided into four groups with two Jerseys and two Holsteins in each group. Group 1 was fed sodium phosphate; Group 2, bone ash; Group 3, air-slaked lime; and Group 4, no mineral supplement. One-half the cows in each group were given green feed whenever available, to find whether it had any influence on the proper utilization of the mineral matter.

This project was discontinued at the end of the first year as considerable difficulty was experienced with the cows receiving no green feed. A tabulation of the yields of milk and butterfat did not show any advantage from feeding minerals either in quantity of production or persistence of milking. Fully as much difficulty was experienced in getting the cows bred when minerals were used, as when no minerals were fed.

MILK SUBSTITUTES FOR CALVES

This project is intended to develop a practical method of feeding dairy calves under Arizona conditions where an insufficient supply of milk is available for calf-feeding. During the last year 11 calves were successfully raised to 5 months of age on the home-made calf meal, no milk being given after the calves were 40 days old.

TABLE XIV.—YIELD OF DAIRY COWS AT THE UNIVERSITY FARM, 1922-1923.

Name of cow	Breed	Days dry before calving	Days in milk	Yield in pounds		Average pct. butterfat
				Milk	Butterfat	
Childeberte	Jersey	0	365	5,507 6	353.77	6 42
Arizona Butter Girl	Jersey	46	319	9,021.5	537 34	5.95
Arizona Gipsy Draconis	Jersey	51	314	9,214 8	513 56	5 57
Butter Girl's Noble Lass	Jersey	39	326	4,836 9	323 17	6 68
Myrtle's Noble Eminent Lass	Jersey		365	4,452 7	229 75	5 15
Noble Eminent Princess	Jersey	72	293	4,418 3	271.84	6 15
Aldan's Oxford Nora	Jersey	61	304	5,627 1	372.04	6 00
Average for Jerseys			327	6,154 1	371 63	6 03
Theresa Belle 3rd	Holstein	45	320	20,711 3	667.58	3 24
Madison Martha 2nd	Holstein	49	316	16,965 5	443 31	2 61
Miss Pell Pietertje	Holstein	64	301	18,916 2	647 92	3 42
Theresa Belle DeVries	Holstein	53	312	21,107.2	627 65	2.97
Moensje Jess Aspirante 2nd	Holstein	61	304	14,298 3	519 72	3 63
U. of A. Dichter Belle Liscomb	Holstein	37	328	11,448.3	392 86	3.44
Average for Holsteins			313	17,241 1	549 84	3 18

ENTOMOLOGY

C. T. VORHIES

Projects of this department reported upon in the Thirty-third Annual Report have been continued, and a project on the grape leaf-hopper has been added.

RANGE RODENTS

Investigations on rodents of the grazing ranges now center on the jack rabbits. Much material has been added to our knowledge of the life histories of the two distinct species concerned. To secure definite and accurate information on the specific kinds of food plants eaten or preferred by these animals, is proving much more difficult than was the case in the kangaroo-rat investigations, where large amounts of stored supplies were available for accurate tabulation. By attending rabbit drives in the spring it was hoped to secure data, especially on breeding, much more rapidly than by the usual methods, but this proved to be disappointing in actual results.

THURBERIA BOLLWORM

As noted in the last annual report work on this insect, believed to be a potential pest of cotton, can be actively prosecuted during only a short period of time in the autumn. Additional life history data were secured in the fall of 1922. Completion of the necessary time cycle for the test on susceptibility of the insect in the pupal stage to irrigation practice yielded no results, since no moths issued even in the control cage on non-irrigated, well-drained soil. The plan of placing larvae singly in a series of small flower pots in the laboratory for pupation, afterward burying these pots in the out-of-door cages may have been responsible for the failure to secure emergences. Hence in the fall of 1922 the plan of placing numbers of larvae directly on the soil in the cages, and allowing them to enter and pupate without other restriction or artificial condition, was adopted. Results from this cannot be obtained until August, 1923.

A few domestic cotton plants grown at Agua Caliente Ranch to determine whether the bollworm moths would deposit eggs thereon gave negative results. The same experiment attempted at Wm. Nicholson's ranch in the Santa Rita Mountains in very close proximity to wild cotton failed owing to destruction of the two plantings of cotton by rodents, after which it was too late to replant. Abandonment of another test of the same kind planned for the season of 1923 can be reported now, since scarcity of water due to the extreme drouth of the preceding winter has resulted in loss of the cotton planted for the purpose.

It may be noted that in this report the name "Thurberia bollworm" is used as the common name of this insect, replacing the name "Arizona pink bollworm" as used in the previous annual report. This name is less likely to be confused with that of the "Egyptian pink bollworm," which is not at all nearly related to our native bollworm of wild cotton, *(Thurberia thespesioides)*.

BEE CULTURE

The season of 1922 was only a moderately good one for honey in southern Arizona, especially where the beekeepers were wholly dependent on the native honey plants. The summer rainy season did not produce a commercial flow in the flowers of the native flora. As concerns this, an interesting experiment was made with the University apiary. By moving the colonies a few miles it was possible to locate them at the edge of a 10-acre field of Hubam, the new annual white sweet clover. From this a fair yield was secured, but the honey is somewhat darker than, and in flavor inferior to, our mesquite and cat's claw honeys.

MISCELLANEOUS

Putnam's scale *(Aspidiotus ancylus)* not hitherto recorded in Arizona has been reported to this office by Mr. C. J. Wood, of the Salt River Valley Farm. Specimens from apricot trees were received and determined by an expert in this group of insects. The same species was also reported as occurring on peach and plum. Although a member of the same genus as the San Jose scale and requiring the same control measures, it appears from such reports as are available to be much less pernicious and dangerous.

Unusual numbers of cicadas (so-called locusts) occurred in southern Arizona in the summer of 1923. They were so much more numerous than usual as to suggest the possibility of their being a hitherto unrecorded periodical cicada. These insects did some damage by oviposition in the smaller branches of cotton plants in occasional fields in the Salt River Valley, the damage being estimated at 15 percent in one instance.

One station publication, after considerable delay, came from the press this year. This was the bulletin on the kangaroo rat, printed by the Government Printing Office, and issued as Bulletin 1091 of the United State Department of Agriculture, and also as Technical Bulletin No. 1 of the Arizona Agricultural Experiment Station, under the joint authorship of Charles T. Vorhies and Walter P. Taylor.

HORTICULTURE

F. J. Crider, D. W. Albert

The results accomplished in investigative work in horticulture during the past year have been most satisfactory. The observations made and the data accumulated are of material value to fruit and vegetable growers, and should be a means of encouraging safe practices in horticulture in Arizona.

An outline of the general progress of the work during the year ended June 30, 1923, is given below.

DATE STUDIES

The Tempe Date Orchard produced its first full crop of fruit since 1920 when it was completely defoliated and "torched" to eradicate the Parlatoria scale.

Fig. 3.—Rooting date palm offshoots in the nursery row. Note that they are wrapped with burlap. Salt River Valley Experiment Farm.

PROPAGATION

The first systematic study of date propagation by the Arizona Agricultural Experiment Station was begun in the spring of 1919. This work, at both the Yuma and Salt River Valley Experiment farms, consisted mainly of a comparison of the effects of different rooting media, and atmospheric protection on the rooting of offshoots. It was shown conclusively that the kind of rooting medium used had little effect in inducing the growth of roots, as the offshoots rooted equally well in sand, ordinary soil, or stable manure, when kept uniformly moist. It was also shown that the offshoots rooted equally as well under ordinary field conditions when they were wrapped with burlap, as when they were grown under lath shelter, and that they rooted better in the open field than they did in the canvas-covered house.

The most important fact gained from this investigation is that, under every condition of rooting medium and exposure, the highest percentage of growing plants was obtained from offshoots that were partly rooted before being detached from the mother palm. This was particularly noticeable in the work at the Yuma Mesa Station where under both field conditions and shelter the only offshoots of the 1921 cutting that grew were those taken from a date palm around which silt had been accidentally banked in cleaning an irrigation ditch, causing the offshoots near the base of this palm to develop roots while still attached to the parent tree.

Fig. 4.—The same lot of offshoots as shown in Fig. 3, one year later. Note the growth.

BOXING OFFSHOOTS TO FACILITATE ROOTING

The observation that date offshoots rooted more readily with soil banked around them before being detached from the mother palm led to further experimentation in this direction. First, soil was banked around the bases of the offshoots located near the ground, and the fact that this proved effective in inducing rooting, suggested the boxing of high offshoots.

In April, 1922, this method of rooting was first tried. The operation consisted in constructing a rough lumber box around the offshoots so as to

Fig. 5.—Showing the boxing of high and low offshoots. The boxing for the lower offshoot was built up from the ground.

allow the entire base to be covered with soil. Somes boxes were placed near the ground, and others as high as 8 feet above the ground on the trunk; these boxes were filled with soil which by frequent watering was kept moist. Six weeks later one of the offshoots so treated was accidentally dislodged, revealing the fact that already it had developed roots; by October all the offshoots that were boxed were found to have developed satisfactory root systems. Later experiments indicated that peat is a more satisfactory rooting material for high offshoots, in that it holds moisture better than does either soil or manure. In transplanting offshoots in this way it was found that those having a well-developed root system made the most satisfactory growth.

This method of rooting date offshoots will be given further study. In view of the great losses of offshoots sustained in attempts to propagate the date, this observation should be a stimulus to the date industry in the Southwest.

DATE VARIETIES

Records of the behavior of date varieties during the past year confirm previous observations. Unfortunately some of the better varieties, from which no offshoots were grown, have passed the age of offshoot production, and since it is difficult, if not impossible now to obtain more of these offshoots from the Old World, these varieties are practically precluded from consideration in future plantings. Of the varieties having available offshoots in this country, the Saidy shows much promise for commercial planting, particularly in the foothill districts and high mesas of southern Arizona where the ripening season is longer and the humidity less than at the Tempe Date Orchard. However, very high quality Saidy fruit was produced at the Tempe Date Orchard last year, owing to the very favorable season; also a very good quality of Deglet Noor dates was produced at the Tempe Date Orchard. Other varieties, outstanding in their behavior at the Tempe Date Orchard are the Iteema, Hayanay, Tadala, and Maktum. Particular attention is called to the Tadala as one of the few early-ripening dates that is not injured by humid weather.

CITRUS FRUITS

The citrus orchard at the Yuma Mesa Station, planted in 1920, ripened its first fruit this year. A number of Marsh Seedless grapefruit and Washington Navel trees bore from six to eight fruits each.

Ten acres of this planting have been handled uniformly from the beginning in preparation for a fertilizer experiment, which was begun in the fall of 1923. The experiment consists of 18 different fertilizer combinations with appropriate check plots. While no conclusive results can be expected yet, it is notable that the trees to which ammonium sulhate was applied at the rate of 1' pound per tree for each of four applications during the growing season, thus far have made the best showing. The effect was seen in a decidedly darker foliage and a more vigorous tree growth. This was so apparent that citurs growers on the Yuma Mesa have adopted the practice of applying this form of fertilizer to young trees. A somewhat similar fertilizer experiment was started in the Salt River Valley with older trees, in cooperation with growers, but the first year's results showed no noticeable effect from the fertilizers.

The further use of orchard cover crops on the Yuma Mesa confirms the findings already made by the Experiment Station, namely, that the seed must be inoculated before satisfactory legume cover crops can be produced. Of the large number of legumes grown as orchard cover crops, the vetches (purple and common) and sour clover in winter, and cowpeas in summer, have proved most satisfactory* Recently biennial white sweet clover *(Melilotus Ma)* has shown much promise, owing to its quality of deep rooting and its long growing season.

ROOT STUDIES

During the past year a preliminary study was made of the relative location of the root systems of citrus trees of different ages and on different soils, measured in feet below the surface. The determination was made by making a vertical cross-section at the drip of the branches, 30 inches wide and long enough to extend a quarter of the distance around the tree. The soil from this area was removed and the roots were carefully screened, washed and weighed.

TABLE XV—SHOWING RELATIVE LOCATION OF CITRUS ROOTS AS MEASURED IN FEET BELOW THE SURFACE.

	3-year-old tree Sandy soil Yuma Mesa	6-year-old tree Sandy soil Yuma Mesa	25-year-old tree Sandy soil Yuma Mesa	25-year-old tree Sandy loam soil Tenacious subsoil Salt River Valley
Feet	Per cent of roots	Per cent of roots	Per cent of roots	Percent of roots
1st.	41 42	44 55	3 02	17 09
2nd.	14 68	39 27	24 17	47 89
3rd	30 77	14 39	12 38	24 80
4th	13 13	1 79	9 80	10 00
5th.			4 50	00 24
6th.			05	
7th,			4 53	
8th.			05	
9th.			05	

In connection with these root studies, soil moisture determinations were made in cooperation with the Agricultural Chemistry Section to find the depth of moisture penetration in relation to the root system of citrus trees. There was a decided loss of soil moisture in the first 3 feet of soil which is the area of greatest root development; below that depth the moisture remained constant, after the first influence of irrigation. The trees indicated by the appearance of the foliage the need for water about 12 days after irrigation. At this time the moisture content of the first foot of soil approached the wilting point, while the second and third feet showed relative deficiency. Through this investigation the length and frequency of irrigations have been regulated on the Yuma Mesa. It is evident, that on the deep, sandy soils of this district, light, frequent irrigations are the only satisfactory means of maintaining an adequate moisture supply within the root zone without causing a waste of water.

A study of newly planted balled trees on the sandy soils of the Yuma Mesa district showed that trees must be handled carefully for the first few months after planting in order to keep the balls moist. It was found that in many cases the newly set trees were actually suffering for water while the soil immediately adjacent to the ball contained an ample supply of moisture. Table XVI shows the difference in moisture content of the tree-ball and adjacent soil 6 weeks after planting, and 10 days after irrigation.

TABLE XVI.—SHOWING THE DIFFERENCE IN MOISTURE CONTENT OF TREE-BALL AND ADJACENT SANDY SOIL, 10 DAYS AFTER IRRIGATION.

Soil area examined	Total moisture	Wilting point	Available moisture
	Percent	Percent	Percent
Within tree-ball	3 80	3 00	0 80
Outside tree-ball	4 70	1 70	3 00

The Athel or Evergreen Tamarisk trees *(Tamarix articulata)* planted as a windbreak around the citrus orchards on the Yuma Mesa Experiment Station were competing seriously with the adjacent citrus trees for water and fertilizer. To stop this intrusion of the tamarisk roots, a trench 4 to 5 feet deep and 18 inches wide was dug between the tamarisk windbreak and the citrus planting. It was hoped by means of this trench to prevent the tamarisk roots from growing into the soil of the citrus orchard. Two months later it was noticed that the tamarisk roots were growing beneath the trench.

VARIETY PLANTINGS

Of the 30 varieties of citrus being tested on the Yuma Mesa Station, the following kinds bore the first fruit this year: Marsh Seedless, and Foster grapefruits; Washington Navel, Mediterranean Sweet, Avery Early, Ruby Blood, and Valencia oranges; Lisbon and Eureka lemons; Mexican, and Rangspur limes; Dancy, and Willow-leaf tangerines; Sampon tangelo; Cedrola; and Citron of commerce.

BUD SELECTION

Bud-selection work, which was started 3 years ago in the Salt River Valley citrus district, has been continued with satisfactory results. A number of growers have been encouraged to keep individual tree records, which will furnish the basis for an ample supply of bud-wood from trees having a known record of high production. In addition a few outstanding, promising strains of the Washington Navel orange have been located in older groves, and are being closely studied; also a few early, seedling strains.

THE OLIVE

An experiment to determine the effect of pruning on the size of the olive indicates, from results obtained during the past 3 years, that pruning has no influence on the size of the fruit. Two general types of pruning have been used in comparison with unpruned trees; "short" pruning in which the annual terminal growth is shortened approximately one-third, and "long" pruning which consists in thinning the trees without heading the branches.

GRAPES

Grape plantings made at the Salt River Valley and Yuma stations in 1922 for the purpose of conducting experiments in pruning, heading, training, irrigation, and fertilizing have made satisfactory growth. The pruning, heading, and training work was started during the past year, but definite data will not be available until the vines come into full bearing. On account of a lack of funds the experiments in irrigation and fertilizing were postponed.

GRAPE VARIETIES

The variety grape planting at the Salt River Valley Experiment Farm has continued to give valuable data. The Malaga and Sultanina (Thompson Seedless) varieties appear outstanding in adaptability to southern Arizona conditions, but other varieties showing much promise are the Cornichon, Black Malvoise, Black Muscat, Panarita, and Almeria. The last named grape is very promising as a market variety on account of its heavy-bearing, late-maturing, and good-keeping qualities. Tests made during the past spring show that it is self-fertile in Arizona.

A NEW GRAPE

What promises to be a valuable new grape has been observed at the Salt River Valley Experiment Farm. Its outstanding characteristics are vigor, excellent flavor, high color, and good shipping qualities. It ripens late in summer when no other highly colored market grape is available in Arizona. This grape has a skin so tough that the green June bug *(Allornina mutabilis)* does not attack it. A detailed description and history of this grape is being prepared.

PRUNING DECIDUOUS FRUITS

This project consisting of a comparison of the long, short, and intermediate methods of pruning yielded its first satisfactory data this year, the trees having just reached good bearing age. This year's crop, though not heavy, served to indicate a decided difference In results obtained from the different pruning systems. In the case of the long system of pruning the yield was comparatively heavy, but the fruit was of small size; the short system of pruning produced a light crop of large fruit. The intermediate system combines the good qualities of both the long and the short systems of pruning, without including their disadvantages. Perhaps the greatest factor in favor of the intermediate system over the short-pruning system is the earlier ripening of the fruit. The results are sufficiently conclusive that this method is recommended as the most desirable one for Arizona conditions.

WALNUT AND PECAN STUDIES

In a study of the adaptability of the pecan to Arizona conditions it has been found that this nut succeeds well on our deep, river-valley soils, but does not thrive where caliche or other hardpan is near the surface. Repeated efforts to grow the pecan at the Salt River Valley Farm, where the soil is comparatively shallow, have met with failure, but on the deep soil of the Yuma Station it has made a very satisfactory growth. It is also apparent that the pecan is not tolerant to alkali, as has been shown by ineffectual efforts to grow it on the more alkaline soils of the Yuma Valley station.

It will be some years before the question of variety adaptation can be settled, but judging from the behavior of bearing trees in widely separated parts of the State, the Success, Schley, and Delmas can be depended upon to succeed.

It has been found that under the dry atmospheric conditions of Arizona it is necessary to use great care in transplanting and handling young pecan trees. Severe cutting back at the time of planting, and providing partial shade during the first growing season are essential for best results.

Work with the walnut consisted largely in top-grafting commercial varieties upon the native walnut *(Juglans major)* to determine the adaptability of varieties to different locations. The grafts have not yet reached bearing age, but it is evident from results thus far obtained that commercial walnut culture must be confined to comparatively restricted areas at mid-elevations. The walnut has not succeeded in the lower valleys nor at the higher altitudes in the State.

FRUIT-GROWING UNDER DRY-FARM CONDITIONS

The behavior of the orchard at the Prescott Dry-Farm this year under good cultural conditions demonstrated the possibility of growing fruit in parts of Arizona where the rainfall is moderate. The average rainfall at the Prescott Dry-Farm is 15.42 inches, but during 1922 it was considerably below this amount. There was little rainfall during the winter, and during the months of April, May, and June, when the trees were flowering and bearing fruit, only .33 inch fell. Notwithstanding this shortage of rainfall the trees produced good crops of first-class fruit. This planting consists of apple, pear, peach, plum, prune, and cherry trees, also some grapes and currants.

The small fruit planting in the Greaterville district which was begun in the spring of 1922 came through the summer in remarkably good condition, indicating that it may be possible to establish orchards and vineyards in this section without irrigation. It was found necessary to water the young plants twice before the summer rains began; now that they are well established it is expected that they will grow with the natural rainfall of the region, which is about 16 inches. The planting consists mainly of grapes and other small fruits.

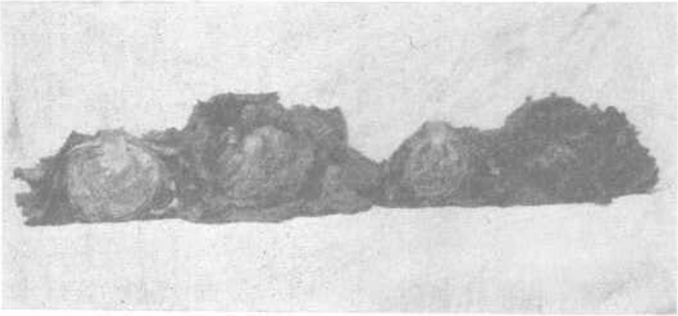

Fig. 6.—Showing effect of acid-phosphate upon size and compactness of lettuce head. Left, head from acid-phosphate plot. Right, head from check plot without fertilizer.

LETTUCE

In an experiment conducted at the Yuma Valley station to determine the effect of commercial fertilizers upon lettuce, acid phosphate was found to have a remarkable effect in hastening maturity and increasing the compactness and size of the head. No appreciable effect was seen in the use of potash and sulphur, nor in the use of the different forms of nitrogen when applied alone, but when these were applied with acid phosphate, decided effects were produced. The most outstanding of these combinations was with blood meal. In this case the factor of earliness was retained and at the same time the size of the head was materially increased. This experiment will be duplicated next year.

SWEET POTATOES

The results of the experiment to determine the effect of vine-pruning on the yield of sweet potatoes confirm the data obtained last year. This year's data are shown in Table XVII. The potatoes produced under the practice of vine-pruning were of very inferior quality.

TABLE XVII.—SHOWING THE EFFECT OF VINE PRUNING ON THE YIELD OF SWEET POTATOES.

Variety	Yield per 300 feet of row		
	Vines natural	Vines pruned to 2 feet	Vines pruned to 1 foot
Porto Rico	75 lbs.	25 lbs.	14 lbs.
Nancy Hall	92 lbs.	28 lbs.	23 lbs.

An experiment conducted during the past year to determine the effect of distance of planting on yield and size, shows the closer planting to be the most satisfactory. The results of the experiment are summarized in Table XVIII.

TABLE XVIII.—SHOWING THE EFFECT OF DISTANCE OF PLANTING ON YIELD AND SIZE OF SWEET POTATOES.

Variety	Distance between plants in the row									
	8 inches		12 inches		16 inches		20 inches		[illegible] inches	
	Yield in lbs.	Size	Yield in lbs.	Size	Yield in lbs.	Size	Yield in lbs.	Size	Yield in lbs.	Size
Porto [illegible]	150	Small	116	Small	100	[illegible]ium	123	Medium	78	Large
Nan[illegible]	153	Small	150	Small	100	[illegible]ium	128	Medium	125	Large

Size as shown in the table refers to the general average. It was noted that the wider spacing gave extremes in sizes.

The results of this year's work on the effect of over-irrigation upon the yield and quality of sweet potatoes confirm the findings of last year. The heavily irrigated plots produced a lighter yield, and the potatoes were very irregular in shape.

IRISH POTATOES

In a comparison of northern-grown seed potatoes, and locally grown potatoes held in cold storage, the former gave larger yields and the potatoes were of more uniform size. The northern-grown seed also gave a better stand with a more vigorous vine growth than did the locally grown seed potatoes.

TABLE XIX.—SHOWING THE COMPARISON IN YIELDS OF NORTHERN-GROWN AND LOCALLY GROWN SEED POTATOES.

Variety	Locality	Yield marketable potatoes, acre basis	Yield, culls acre basis	Total field acre basis
	Locally grown	1,332 lbs	399 lbs.	1,731 lbs.
	Northern-grown	6,600 lbs.	473 lbs.	7,073 lbs.
	Locally grown	1,408 lbs.	792 lbs.	2,200 lbs.
	Northern-grown	1,280 lbs.	416 lbs.	1,696 lbs.
	Locally grown	1,001 lbs.	475 lbs.	1,476 lbs.
	Northern-grown	5,456 lbs.	1,263 lbs.	6,719 lbs.

IRRIGATION

G. E. P. SMITH, W. E. CODE, H. C. SCHWALEN

The studies and activities of the Irrigation Section for the year have been varied, covering many related fields. Chief attention has been devoted to a continuation of the studies of the groundwaters of Arizona and their availability as water supplies for irrigation. Many requests for consultation and advice have been annswered.

GROUNDWATER STUDIES

In the Casa Grande Valley, on account of the depression in agriculture, many pumping plants have been idle or have been used but little since 1920. During 1922 and 1923 the area irrigated by pumping has been about 5,000 acres, including about 1,500 acres on which pumped water is used as an auxiliary to the gravity water supply from the Gila River. A survey of the water table in May, 1923, showed it to be about normal, with the exception of a small area in the Tweedy district where the levels were between 1 and 2 feet below normal, and another area along the Gila River where the water table was depressed between 3 and 4 feet, due to the unusually low recharge from the Gila River flow during the preceding year.

In the Santa Cruz Valley the loss of stream-flow by seepage in 1922 was 7,000 acre-feet between Tucson and Sasco. Practically all of this constituted recharge to the groundwater supply. The loss between Sasco and the Southern Pacific Railroad was 11,400 acre-feet. In 1923 the corresponding figures were 13,900 acre-feet, and 21,500 acre-feet, respectively. The recharge from stream-flow is of great importance, particularly to the project of the Pima Farms Company.

A survey of the Babocomari Valley was made in November, 1922, to determine the position of the water table and its relation to the mesquite forest which covers the lower end of the valley.

A survey of the Hereford artesian area and vicinity was made in August, 1922, and the pie?ometric lines were mapped. The groundwaters of this vicinity have been but partially developed.

In the San Simon artesian area the pressures and discharges of 12 selected wells were measured at four different times during the year. Pumping plants have been installed on a few of the wells, most of them being near the south end of the artesian district. Pumping at one of these wells produced a lowering of 4 feet in a well a half-mile away. There is abundant evidence that the water supply of the district constitutes one reservoir from which the supply of each well is derived. The practice of leaving wells uncapped and of allowing the artesian flows to run to waste during a considerable part of the year is, therefore, damaging to the district and is very reprehensible.

A groundwater survey of the Duncan-Franklin Valley was made in June, 1923. Logs of wells were secured, depths to the water table were measured, samples of water were taken and analyzed, and a map was made showing the location of wells and their relation to the topography. The information gathered indicates that a water supply valuable for irrigation purposes and of good quality is available for the bottomlands along the river. Above the bottomlands on the sloping benchlands, the quality of the water is in general, poor and the yields of wells are small.

Similar surveys were made in McMullen Valley and in the Gila Valley from Gila Bend westward to Yuma. The latter is especially timely because of efforts now being made to colonize these benchlands along the Southern Pacific Railroad.

These surveys permit of answering the many inquiries regarding groundwater conditions which come to the Experiment Station. When similar surveys have been made throughout the State, it will be possible to determine approximately how much hydroelectric power will be required ultimately, and hence should be reserved for irrigation pumping.

A second continuous water-level recorder was installed in a well of the Pima Farms Company on June 2, 1923, to assist in the study of well interference and the character of groundwater movements. Relationships have been shown between the rate of travel of interference waves, the distance, the lowering of the water table, and the character of the valley fill. Approximations of the amounts of water removed from the groundwater supply as shown by the water-level records are in close agreement with the pumping records of the Pima Farms Company.

EFFECT OF TRANSPIRATION UPON THE GROUNDWATER SUPPLY

The two transpiration stations at Redington previously reported were maintained until September, 1922, and comparative records were obtained on the cottonwood well, and on a well in the open outside of the forest in October. A topographic map of the Redington area has been prepared.

One set of equipment was installed November 9, 1922, in a heavy growth of sacaton grass *(Sporobolus Wrightii)* on the bottomland of Gardiner Wash near Empire Ranch, in Sec. 21, T. 19S., R. 17E. Sacaton is a tall bunch grass growing 6 feet high and shading the entire ground surface. The water table is about ten feet below the surface. Another set of equipment was installed on a salt-grass *(Eragrostis mexicana)* flat about six miles southwest of Willcox, in the NE ¼ of Sec. 21, T. 14S., R. 24E., on April 9, 1923. The water table here is at the ground surface at times, but recedes during dry periods to about three feet below the surface. A sample of water taken from the pit contained over 200 parts per 100,000 of sodium carbonate (black alkali).

At both the sacaton and the salt-grass stations the effects of transpiration were found to be analogous to those previously found at the mesquite and cotton wood stations.

A paper entitled "The Measurement of the Transpiration of Trees with Respect to the Groundwater Supply" was prepared and read before the Geological Society of Washington, in January, 1923.

THE SAN SIMON ARTESIAN WELL TEST

A contract for the drilling of a well 2,000 feet deep 6 miles southeast of San Simon was signed June 20, 1922. The contract was written by the attorney of the State Land Department, using specifications prepared by this office.

Actual drilling was begun on December 18, 1922, with a No. 27, Star portable steam rig, and a 72-foot standard derrick. Sixteen-inch, No. 10, stovepipe casing was driven to a depth of 177 feet, and 10-inch, screw-joint, well casing was sunk to a depth of 1,200 feet as required by the contract. A string of 8¼-inch Diamond BX casing was then placed in the well and was sunk to 1,583 feet. At that depth, on June 15, 1923, it became fast and could not be lowered or raised. No progress has been made since that date, although several alternatives are open to the contractor, and he is required by the terms of the contract to complete the well to a depth of 2,000 feet.

The well is in unconsolidated deposits, probably of Pliocene age, from the surface to the bottom. The deposits are practically all clay and silt and very fine sand. The "blue clay" which occurs throughout the artesian area was encountered at 120 feet below the surface.

STREAM-FLOW MEASUREMENTS

Stream gaging has been continued at 11 stations, in Cochise, Pima, and Pinal counties, and an approximate record is being obtained of the flow of Centennial Wash near Salome. The purpose of these records is the determination of the amount and dependability of runoff from areas of different kinds—mountain and plain—and in connection with groundwater recharge studies.

PUMPING MACHINERY

Considerable study has been made of the characteristics of propeller pumps, which are again coming into use, and of electrical equipment for substations at pumping plants.

New wearing rings were placed in the 3-inch pump in the Agriculture Building well. Measurements of the discharge showed that the quantity of water pumped was increased from 230 to 260 gallons per minute.

POULTRY PLANT WELL

A new well was drilled on the grounds of the University poultry plant in 1922 under the supervision of this office. The depth of the well is 151 feet, and the water level stands at 102 feet. The well is cased with 12-inch, No. 12 stovepipe casing. The equipment consists of a Myers plunger pump and a 3-horsepower, single-phase motor. On test, when pumping 18 gallons per minute, the drawdown was found to be only 0.65 foot.

ELECTRICAL DISTRICTS

An act providing for the creation and operation of electrical districts was passed by the Sixth Arizona Legislature in 1923. Two laws passed in 1915 and 1922 respectively and having the same purpose, had been found to be unconstitutional.

The electrical district, like the irrigation district, is a quasi-municipal corporation, a political subdivision of a state. It is not known outside of Arizona; but it is sound in principle, and if properly used, should be of great value in the development of the State. Studies of this law and of its applicability in groundwater development are being made.

THE COLORADO RIVER AND ITS UTILIZATION

The Irrigation Engineer visited the Glen Canyon damsite with the Chief Hydraulic Engineer of the United States Geological Survey in May, 1923.

An additional contribution* to the literature on "Colorado River Projects" was made in September, 1923, and several addresses on the subject have been given.

The plan advocated by the Irrigation Engineer contemplates the immediate construction of the Dewey dam as an emergency measure for partial flood control and increased irrigation water supply, and the construction of a project at the Diamond Creek site or in that vicinity for hydroelectric power. He states also, that the Colorado River Compact as drawn is inimical to the interests of this State.

---

*Arizona Magazine, Vol. XIII, No. 8, September, 1923.

MISCELLANEOUS

The Chino Valley was visited, on request, for consultation on the improvement of the water supply and on re-grading the lands so as to irrigate by the border method.

The records of duty of water in the Salt River Valley have been analyzed.

The manuscript on concrete canal linings noted in the last annual report has been published as a Station bulletin.*

It is worthy of note that the Salt River Valley Water Users' Association is returning to the National Reclamation Fund this year over a million dollars, a little over 10 percent of the original construction cost advanced by the Federal Government.

*Arizona Agricultural Experiment Station, Bul. 97, September, 1923.

PLANT BREEDING

W. E. BRYAN, E. H. PRESSLEY

ALFALFA

Seed crops have been taken from the plant progenies which were obtained from the commercial Hairy Peruvian alfalfa. As has been stated in previous reports, these progenies originated from individual plants whose seeds were grown under cages. The first and second seed generations of these progenies are now growing on adjacent plots at the Yuma Valley Experiment Station. Comparative studies for each of these progenies have been made in both the first and second seed generations as follows:

1. Uniformity within each progeny;
2. Value of hay production;
3. Amount of seed produced.

The first seed generation was grown from self-fertilized seed of the original mother plant. The uniformity shown by each of the first generation progeny seems to indicate that most of the original mother plants were not hybrids with regard to any visible characters. Some of the first seed generation progenies showed some irregularity in type, but it was difficult to tell whether this irregularity was due to hybridity or to irregular soil conditions, such as alkali, and lack of water penetration. In the second seed generation, each progeny type was remarkably true and constant, even though the second generation seeds were from open-pollinated flowers. It has been planned to make a thorough study of uniformity within each progeny as soon as three seed generations can be grown to comparative stages on adjacent plots.

Considerable difference exists between the various progenies in regard to their hay value. Some are fine-stemmed and leafy, while others have coarse stems with scant foliage. There seems to be a tendency to light seed production in the leafy progenies, and to heavy seed production in the non-leafy progenies.

COTTON

The plant-breeding plots were located at Yuma in 1922. Plantings were made of Acala, Hartsville, Lone Star, Deltatype Webber, and Webber 49 cotton. Boll-shedding studies were carried on with Acala, Lone Star, and Hartsville. Comparative lint studies were also carried on with the plant progenies which originated from mother plants of the crop of 1922.

The flowering and shedding studies took up most of the time devoted to the cotton project. One hundred and nine plants each of Acala and

Lone Star, and 63 plants of Hartsville were included in these studies. The flowers on each of the selected plants in these three varieties were tagged daily throughout the flowering season. Each tag was dated and placed on the plant in such a way that it was retained even when the boll shed. At the end of the season the tags were removed from the plants, and the number of bolls shed and the number which matured were determined. From these the percentage of shedding for each plant, and the average for the variety were calculated. The percentages

Fig. 7.—Off-type cotton plant rogued from field of cotton grown for pure seed.

of shedding by plants for the three varieties, Acala, Lone Star, and Hartsville, were as follows:

For Acala:

2 plants shed 51 percent	10 plants shed 56 percent
25 plants shed 61 percent	29 plants shed 66 percent
26 plants shed 71 percent	11 plants shed 76 percent
3 plants shed 81 percent	1 plant shed 86 percent
1 plant shed 91 percent	Average 67 percent

For Lone Star:

3 plants shed 56 percent	13 plants shed 61 percent
19 plants shed 66 percent	37 plants shed 71 percent
27 plants shed 76 percent	10 plants shed 81 percent
	Average.......71 percent

For Hartsville:

1 plant shed 61 percent	6 plants shed 66 percent
13 plants shed 71 percent	28 plants shed 76 percent
13 plants shed 81 percent	2 plants shed 86 percent
	Average.......80 percent

Acala cotton shows the greatest diversity in the percentage of shedding from plant to plant, and also the lowest average percentage of shedding. Single plant selections have been made from the low, average, and high shedding classes with a view to testing the heritability of the degree of shedding.

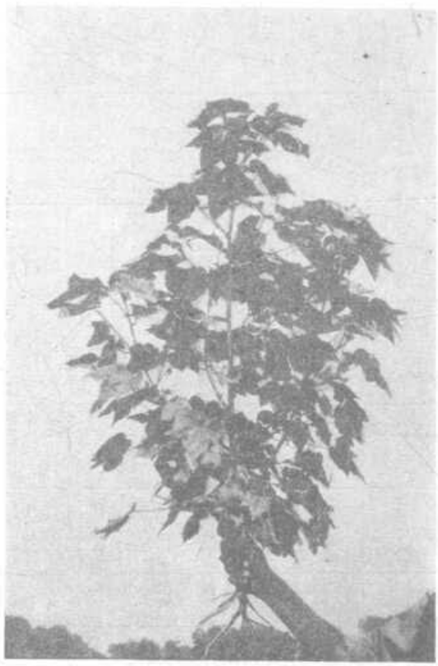

Fig. 8.—Off-type cotton plant rogued from cotton field for producing pure seed; 30,000 pounds of pure cotton seed were produced in the upper Gila Valley at Safford, in 1923.

WHEAT

Forty large increase plots of pedigreed wheats were grown at the Salt River Valley Experiment Farm to test these strains for yield of grain,

TABLE XX.—SHOWING YIELDS OF GRAIN, CHEMICAL ANALYSES OF FLOUR, AND BAKING RESULTS OF ARIZONA WHEATS. CROP OF 1923.

Variety or number	Yield grain per acre	Ash	Protein	True gluten	Quality of gluten	Flour absorption	Loaf value	Loaf texture	Loaf color	Loaves per barrel	Yield straight flour	Rank in baking test
		Chemical analyses of flour				Baking results						
	Bu.	Percent	Percent	Percent		Percent	cc.				Percent	
2216	28	0 50	9 92	8 43	good	58	2090	medium	yellow	299	74 3	1
2211R	61	0 40	12 88	10 93	poor	56	2100	fine	yellow	295	73 2	2
34	33	0 51	9 92	8 43	fair	54	2080	medium	yellow	292	73 4	3
2161	55	0 44	10 24	8 70	very good	56	2200	coarse	brown yellow	295	73 0	5
34-14-9	37	0 47	10 56	8 98	very good	51	2030	fine	white	286	73 0	7
1845-14	30	0 61	11 60	9 86	fair	59	2130	fine	yellow	301	71 6	10
34-14-12	33	0 79	12 16	10 34	fair	62	2020	fine	yellow	306	69 4	11
34-14-17	41	0 82	13 60	11 56	good	64	1970	medium	brown	342	67 8	17
2227	42	0 64	12 64	10 74	good	58	1930	medium	yellow	299	70 0	22
34-14-18	51	0 75	13 92	11 83	good	64	1850	coarse	brown	342	67 4	25
2225	33	0 60	12 64	10 74	poor	60	1865	coarse	yellow	303	72 7	30
36-51	41	0 57	14 08	11 97	fair	56	1850	medium	yellow	295	71 0	32
34-14-13	31	0 75	11 60	9 86	fair	64	1880	medium	yellow	342	67 8	35
2230		0 62	13 84	11 76	fair	64	1800	coarse	yellow	342	69 7	36
Kansas Patent		0 82	10 80	9 18	good	59	1960	fine	white	301		

and for milling and baking qualities. Table XX summarizes the results with 14 representative strains.

Kansas patent flour was used as a check in these tests, and the baking results with this flour have been included in the table for comparison. An inspection of the table shows that some of the Arizona floors compare very favorablv with the Kansas patent flour in the four main points of the baking test as follows:

1. Flour absorption, or the amount of water the flour takes up in making a dough of proper consistency for baking;

2. Volume of loaf, or size of the loaf, usually expressed in cubic centimeters;

3. Color of the baked bread; and,

4. Texture of the crumb.

The grain yield per acre in 1922-23 was somewhat lower than was the average on the Salt River Valley Experiment Farm, although some strains yielded fairly high.

Crossing work with the various strains of wheat is also being carried on in an attempt to produce an improved variety, having strong straw, good quality of grain, smut resistance, and high-yielding qualities.

PLANT PATHOLOGY

J. G, BROWN, FREDERICK GIBSON

INTRODUCTION

In addition to the regular plant disease projects carried during the year, an effort has been made to initiate a plant disease survey of the State. This survey work has necessarily been slow, because no additional help was available. However, some field investigations were made, when time could be spared from the projects and from general laboratory and teaching duties.

SURVEYS

RUSSELL VALLEY

This valley lies between Globe and Miami, in Gila County. Although small, the valley might become important in connection with the growing of vegetables and small fruits, with adequate irrigation facilities, since it lies in the neighborhood of two large mining centers. Practically no irrigation system exists at the present time, consequently small plantings of fruit trees and vegetables have been injured by drought. In some cases the trees were planted far below the crowns, presumably with the intention of reaching a continuous supply of moisture. This deep planting resulted disastrously. Among the diseases noted were crown gall and Texas root-rot of fruit trees, fire blight of apple and pear trees; blossom-end rot of watermelons; bacterial and fusarium wilts of tomatoes; leaf-spot *(Mycospaerella)* of strawberry; canker *(Cytospora)* of cottonwood shade trees;* powdery mildew *(Sphaerotheca)* of rosebushes; and Texas root-rot of privet.

At the time that the survey was made (September, 1922) most of the vegetables and small fruits had been harvested.

YAVAPAI COUNTY

Several valleys comprise the agricultural area of Yavapai County. Grains, vegetables, and small fruits were harvested before the survey was made in September. With the exception of crown gall and Texas root-rot no serious parasitic diseases of crops were in evidence. Texas root-rot had killed peach and apricot trees and alfalfa in several places in the Verde Valley; also, a large part of a fine apple orchard at Kirkland. Alkali injury was noted in the Verde Valley, especially in strawberry beds. Cabbage black-rot exists in Skull Valley, Apples, peaches, and apricots are raised quite extensively in the Oak Creek and Verde valleys, and some of the orchards could be improved by a careful system of pruning and spraying.

*See Timely Hint 138, Ariz. Agr. Exp. Sta. April 17, 1922.

ARAVAIPA VALLEY

The Aravaipa Valley is well adapted to the growing of orchard and small fruits and garden truck. Apple orchards are located in the upper end of the valley; peaches and apricots are grown throughout its length. A few of the orchards are old and have produced abundantly in the past. Crown gall, woolly aphis gall, and Texas root-rot are the worst orchard diseases, the last mentioned being most common in the lower part of the valley. Fire blight occurs on apple and pear trees, but it could be easily controlled. Crown gall is extensive in a few orchards. In one place

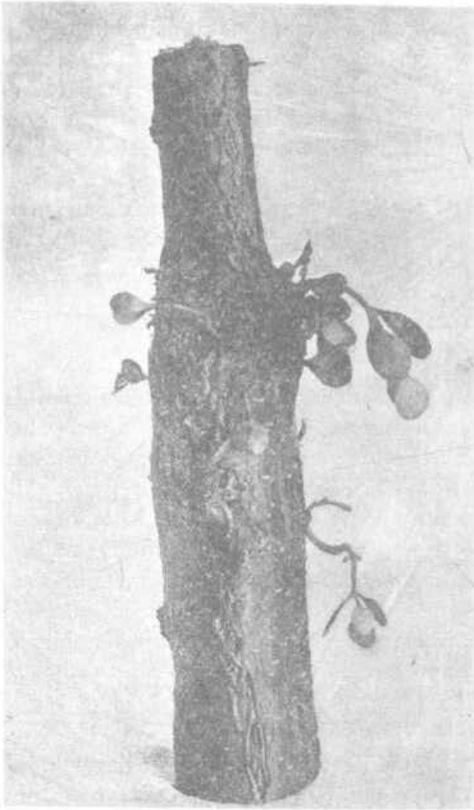

Fig. 9.—Mistletoe (*Phoradendron macrophyllum*) on yellow egg-plum tree.

where hogs were given the run of the orchard a bushel or more of loose galls were scattered about, having been broken off from the trees by the rooting of the animals. Interesting cases of the spread of the common mistletoe *(Phoradendron macrophyllum)*, from the cottonwood to yellow egg plum trees were noted, three trees on each of two different ranches being parasitized.

Several of the farmers of the Aravaipa Valley own herds of cattle and goats. When either beef or mohair commands a high price, there is a tendency to give less time to the orchards than they should have.

Two avocado trees have been growing successfully for several years on one ranch without injury from frost or disease.

RIO SAN PEDRO VALLEY

In the upper part of the valley potato blackleg and rhizoctoniose, fusariose of tomatoes, anthracnose of watermelon, yellows of sweet potato, Texas root-rot and crown-rot of alfalfa, fire blight of apple and pear trees, and some alkali injury have been observed. Chlorotic peach trees and rosebushes were noted in places where alkali was suspected to be present in injurious amounts. Peanuts appeared to grow well on soil which showed a deposit of alkali on the surface. Onions are grown successfully, and appear to be free from disease. Crown gall occurs throughout the valley on fruit trees and grapevines; also Texas root-rot on fruit trees, some shade trees, alfalfa, and certain other plants. Mistletoe *(Phoradendron)* makes a striking display in the lower part of the valley, especially in early spring before the cottonwood and mesquite hosts have become green.

THE CASA GRANDE VALLEY

Several important plantings of vineyards have been made in this valley, which are remarkably free from parasitic diseases. Some losses have resulted from the planting of poorly calloused cuttings of grapevines which were rotted in the field by saprophytic fungi. Both crown gall and Texas root-rot have proved troublesome in local areas, many apricot and peach trees being killed. Alfalfa girdle* (entomological) occurs here as well as in other alfalfa-growing districts of the State. Alkali injury and impermeability of the soil have caused losses to alfalfa growers. A very commendable movement in this valley is the shipping-in of nursery stock in bulk, and its careful inspection by a plant pathologist before being planted.

SANTA CRUZ AND RILLITO VALLEYS

Scab and black scurf of potatoes have been introduced on cheap seed. Some of the growers are beginning to realize now the importance of clean seed potatoes. Sweet potatoes are severely attacked by scurf and black-rot in some localities. Lettuce slime occurs wherever lettuce is grown. Texas root-rot has been found in cotton and alfalfa fields for

*See Brown, J. G and Gibson, Frederick, Some Observations on Alfalfa Girdle Phytopathology 12 188-190 1922, also Osborne, Herbert. Economic Importance of Stictocephala. Jour Econ. Entomol 4 137-140. 1911.

years; as elsewhere in the southern part of the State, it kills many fruit trees. The outbreak of cotton rust *(Aecidium gossypii)* in the Postvale district during the summer of 1922 was perhaps the first to occur in this State. Durango cotton was free from the rust; fields of Acala cotton well supplied with water were more severely attacked than were those which had received less irrigation. Volunteer plants of Pima-Egyptian cotton, the only ones of that variety observed in the district, were quite severely attacked. Fusarium wilt of chili peppers is troublesome in the Rillito Valley. Cytospora canker of cottonwoods and poplars is widely distributed.

Fig. 10.—Pima-Egyptian cotton on alkaline soil plot.

COTTON STUDIES

SEED TREATMENT

Continued experiments with various treatments for sterilizing the surface of cotton seed only serve to demonstrate the superiority of sulphuric acid for this purpose. Wood alcohol diluted with water to 75 percent and used alone or preceding treatment with 1 to 1,000 mercuric chloride solution, gives good results in the laboratory. The alcohol quickly drives air bubbles out of the lint mass and wets thoroughly the seed coat, but the treatment is too expensive and delicate for general use. No other aqueous solution has been successful on account of the difficulty with which the seed coat is wetted.

The use of concentrated sulphuric acid* has several advantages. The acid is cheap; the smooth, delinted seed is easier to handle in planting than the linted seed; a more uniform stand is obtained because the seed feeds uniformly through the planter and more seeds germinate; the germination period is shortened 1 to 5 or more days, thus virtually extending the growing season. The sulphuric acid treatment of cotton seed is of special value to cotton growers operating on heavy soils which "bake" soon after irrigation, since the seed treated with acid germinates at once

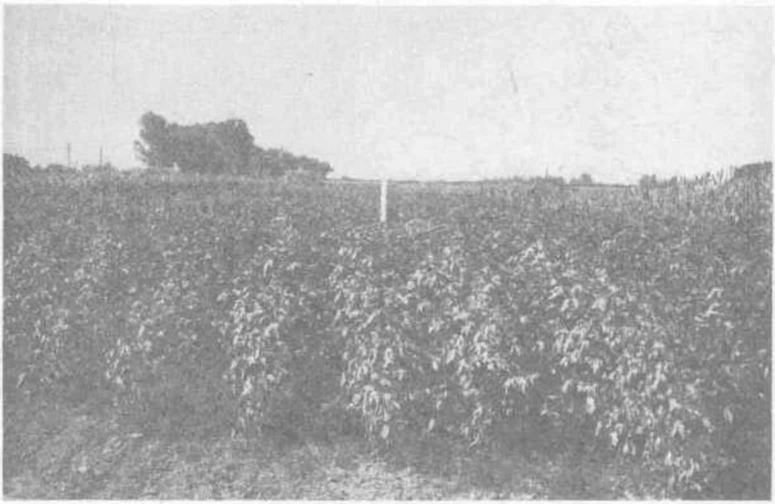

Fig. 11.—Pima-Egyptian cotton on alkali-free soil plot.

and the young plants come through the soil before the latter forms a "crust." A cottonseed-treating machine which will handle large quantities of seed is in course of construction.

EFFECT OF ALKALI ON THE PREVALENCE OF ANGULAR LEAF-SPOT OF COTTON

Striking results have been obtained in continuing the study of the effect of alkali on the prevalence of angular leaf-spot in Pima-Egyptian cotton. Field experiments made in 1922-23 were supplemented with experiments in a screened garden on the Campus of the University of Arizona.

*See Timely Hint 142, Arizona Agricultural Experiment Station, Oct. 20, 1922.

In the field experiments two plots were used, each an acre in size, one consisting of alkaline soil and the other of alkali-free soil. The plots were located about two miles apart in the Salt River Valley. The alkali plot (Fig. 10) had spots where the concentration of alkali salts, sodium chloride and sodium carbonate, was strong enough to prevent the growth of cotton. Chemical analyses* showed here a concentration of sodium chloride in the first foot of soil varying from 0.168 percent to 0.520 percent and sodium carbonate from 0.085 percent to 0.305 percent. The strong alkaline soil (of the spots) graded into soil of lower alkali concentration which produced thrifty cotton plants. The latter soil composed the greater part of the plot. Analyses of soil in the alkali-free plot (Fig. 11) were negative for alkali.

In the screened garden the soils were placed in 16-inch pots which were paraffined and provided with drainage tubes which discharged into jars beneath the pots, so that the percentage of alkali salt could be controlled. The alkaline soil used contained 0.4 percent of sodium chloride.

The Pima-Egyptian cotton seed planted in both field plots was obtained from a common lot of seed. Just before planting, it was soaked in a virulent culture of *Phytomonas malvacera*. The alkali-free plot was planted on April 5 and the alkaline plot on April 10. Observations of the plants in the plots were made carefully throughout the growing season. Alkaline and alkali-free series of pots in the screened garden were handled in much the same way. Planting was made in the screened garden on May 23. In making counts of diseased plants, every individual showing a bacterial spot visible to the unaided eye and located on any aerial part was considered to be infected with *Phytomonas malvacera.*

Comparative results obtained from the plots and the screened garden agree In showing a higher percentage of infected plants on alkali-free soil. In the alkali-free plot the number of diseased plants increased rapidly until it reached a maximum of about 67 percent on May 4, about a month after planting. The infection at this time was almost entirely on the seed leaves or cotyledons. Due to the falling of the cotyledons, to the death of some individuals, and to the process of thinning, but chiefly to the shedding of the cotyledons, the percentage of infected plants decreased rapidly from May 4 until the advent of the summer rains in July, when it again increased. The number of infected plants in the alkaline plot increased slowly at first, then more rapidly, finally reaching a maximum of about 38 percent 2 months after planting. This maximum was followed by a decrease in the percentage of infection which continued until the summer rains began, when an increase again occurred. The maximum percentage of infection on alkaline soil in the screened

*Made by the Agricultural Chemistry Section of the Agricultural Experiment Station.

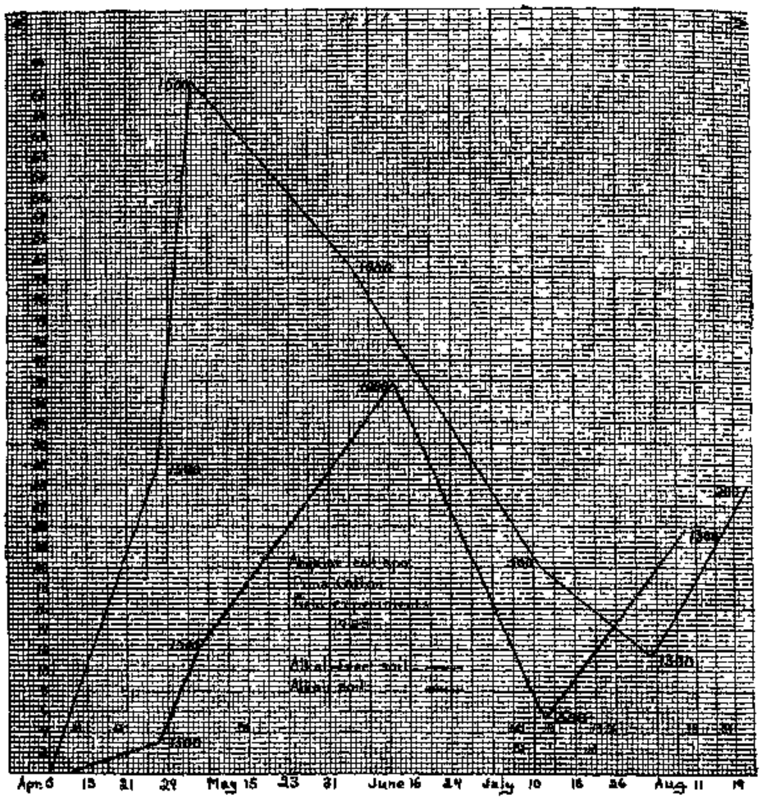

Fig. 12.—Chart showing course of angular leaf-spot disease in Pima-Egyptian cotton on alkaline soil and alkali-free soil, respectively. Numbers in vertical column at left give percentages of infected plants which are read off on horizontal lines bisecting the curves. Each vertical line on chart represents a day of experiment. Heavy numbers on curves represent number of plants examined on which percentage of infection is based. Lighter numbers at base of chart give precipitation (U. S. Weather Report) on date indicated by vertical line passing between first and second figures of each number. Cotton on alkali-free soil thinned May 25th; that on alkaline soil June 12th.

garden was 44 percent as compared with 68 percent on alkali-free soil. One hundred percent of the lesions were cotyledonary up to June 23. The decrease in the number of infected plants was caused by the falling of the infected cotyledons. Summer rains and insects seemed to have no effect in spreading the infection in the screened garden, although the precipitation was normal from the first week in July to the first week in September, and aphids were present on more than 85 percent of the infected plants. Since the plants in the screened garden were protected

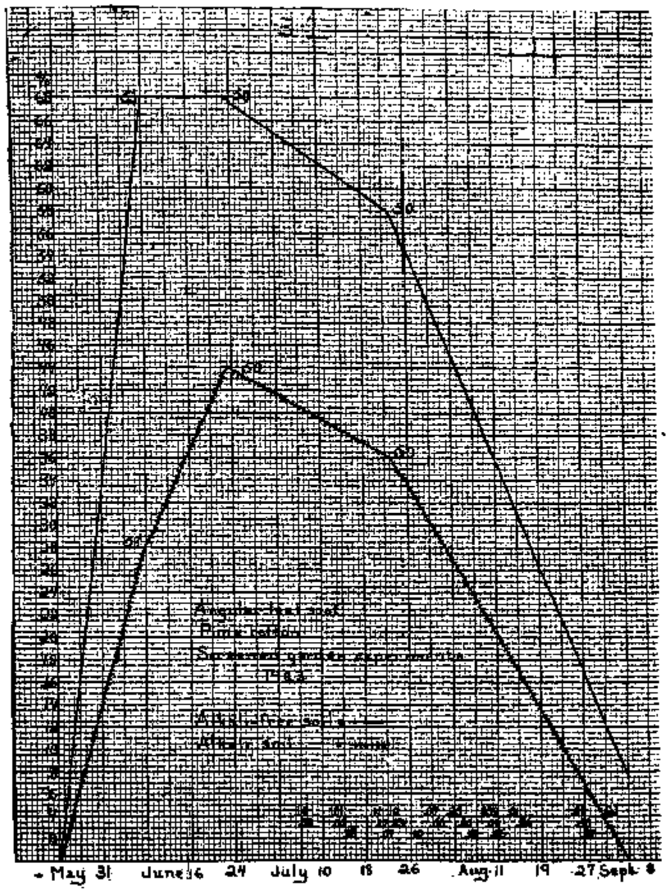

Fig. 13.—Chart showing course of angular leaf-spot disease in Pima-Egyptian cotton on alkaline soil and alkali-free soil in screened garden. Data arranged as in preceding chart.

somewhat from the wind, the spattering effect of the rains naturally would be less than in the field. Infection of the stems of cotton plants frequently resulted from the movement of bacteria through the petiole of infected cotyledons; also from the falling of infected cotyledons against the stem while still attached to the plant.

MISCELLANEOUS STUDIES

MESQUITE BLIGHT

An epidemic of mesquite blight was reported from McNeal, where a forest was defoliated. Leaflets brought to the laboratory from the diseased trees showed an abundance of the fungus *Scleropycnium aureum*, which evidently had caused the defoliation.

SCALDING OF CITRUS STOCK

Several citrus growers in the Salt River Valley have lost nursery beds of sour orange seedlings. The trouble was noticed first about June 1. The two leaves above the cotyledons wilted, died, and dropped, but the stem remained green for some time. The common name of "toothpick disease" is very suggestive of the appearance of the diseased plants. *Rhizoctonia* and *Pythium* were found on the roots of a few individuals, but the injury due to the fungi was not sufficiently extensive to explain the prevalence of the disease. The beds were enclosed on the sides and above with burlap, and irrigation was liberal and the temperature was high; with these conditions injury to the citrus plants may have been caused by scalding.

BACTERIAL SLIME OF LETTUCE

In order to determine whether the bacteria causing the slime disease of lettuce are externally seed-borne, sufficient lettuce seed to plant 5 acres was treated with mercuric chloride solution. The variety used was New York Special. In comparing the plot planted with treated seed with fields of the same variety of lettuce planted on the same farm with untreated seed, no difference could be detected in the amount of slime. It seems probable therefore, that the slime disease of lettuce results from an infection caused by bacteria which are present in the soil, and which gain entrance to the leaves of the plants after the latter have been injured by frost. The disease is always worst after frost. In the laboratory, bacteria have been isolated repeatedly from the parenchyma and veins of infected lettuce leaves, which produce the slime disease when injected into healthy plants. Since fields of Iceberg, New York Special, Los Angeles, and other varieties of lettuce usually show numerous hardy plants, there should be little difficulty in selecting and breeding improved resistant varieties.

POULTRY HUSBANDRY

R. B. THOMPSON, ROBERT PENQUITE

UNIVERSITY OF ARIZONA EGG-LAYING CONTEST

The University of Arizona Egg-Laying Contest compares favorably in results with some of the older, well-established ones. Many requests for entries were made, some of which were from other states. The 20 pens were filled long before November 1, 1922, but due to the death of H. P. Mabry of Bisbee just preceding the opening of the contest, his entry was withdrawn. At that late date it was not possible to secure a substitute, so there were only 19 pens contesting. The contest has been received very favorably throughout the State. This was shown when the poultrymen were asked if they desired to enter a pen for the next year. Seventeen contestants asked for reservations, and on March 31, 1923, there were 23 paid-up entries with but 20 pens for the contest.

The production during the spring and early summer held up remarkably well. This production was maintained in spite of the fact that the hens had insufficient shade and very little green feed. The splendid physical condition of the hens and the exceptionally small loss from heat prostration in summer add strength to what this Station has advocated in poultry management, relative to feeding grain in scratch litter during the entire year. It is a common practice among poultrymen in Arizona to remove all scratch litter* from the houses at the first sign of warm weather. The reason for leaving the scratch litter in the houses is to keep the hens from becoming lazy, their systems from becoming sluggish, and their bodies from becoming over-fat. This year is the first opportunity we have had to demonstrate the advantage of this practice, and it is noticeable that the hens are In splendid physical condition.

During the month of June for the first time in the contest, one hen made a perfect record, having laid an egg every day. At the end of the eighth month the possibilities for hens laying 200 eggs during the year are very promising. Already many of the hens have laid over 160 eggs each. If this production 5s continued, the average for the entire contest will be over 200 eggs.

FOUNDATION FOR EXPERIMENT WORK

The egg production for the year 1922-23 has been lower than it was last year, on account of moving the hens frequently and putting several strange lots together. This was necessary, due to moving fences and equipment to the new poultry plant. The added housing facilities at the new poultry plant gave an opportunity to hold those hens that were designated as culls, in order to observe their production during the summer. This was to determine whether the hens that had stopped laying early in the summer actually began laying early in the fall, or held off production until the late-molting hens had begun to lay.

There are at present 15 breeding houses and yards which are well equipped. It is expected that the average production of the flock will be raised next year; it has been seriously handicapped during the last 2 or 3 years through improper housing and yards.

TABLE XXI—PERCENTAGE PRODUCTION BY MONTHS FOR THE YEAR 1922-1923, OF THE HENS AT THE UNIVERSITY POULTRY PLANT.

Month	Number of hens	Percent production
July	131	44 33 percent
August	131	38 06 percent
September	128	26 92 percent
October	145	16 01 percent
November	185	7 27 percent
December	248	21 80 percent
January	234	34 00 percent
February	230	43 00 percent
March	222	58 00 percent
April	221	57 60 percent
May	221	45 80 percent
June	216	38 50 percent
Average	192 6	35 88 percent

CHICK-FEEDING AND BROODING PROJECT

No work has been done on this project. It was planned to begin the work this season, but the brooding equipment that was ordered did not arrive in time to justify starting the experiment.

DATE OF HATCHING

The following information is available at the present time relative to the standing of this project. It has been found possible to use 10 pullets from each lot in this project. They are developing nicely and give promise of becoming good hens. For this project 10 lots of chicks were hatched at intervals of 2 weeks, beginning February 18, and ending June 24. One pullet of Lot I, hatched February 18, laid the first egg on June 24.

BROILER PRODUCTION

Two experiments with broilers have been completed in this project, with 6 lots of broilers in each experiment* The ration fed to each lot was as follows;

LOT I	LOT II
Ground milo—2 pounds Ground oats—1 pound Shorts—1 pound Water—8 pounds	Same as Lot I, but with 1 pound of semi-solid buttermilk mixed with 7 pounds of water in place of 8 pounds of water.
LOT III	LOT IV
Ground milo—2 pounds Alfalfa meal—1 pound Shorts—1 pound Water—8 pounds	Same as Lot III, but with 1 pound of buttermilk mixed with 7 pounds of water in place of 8 pounds of water.
LOT V	LOT VI
Ground milo—2 pounds Cottonseed meal—1 pound Shorts—1 pound Water—8 pounds	Same as Lot V, but with 1 pound of semi-solid buttermilk mixed with 7 pounds of water, in place of 8 pounds of water.

Following are tables of each experiment, giving the total weight per day for each lot in ounces, together with the total gain in ounces for each lot; also, the dry weight of feed consumed per day in ounces for each lot. There were five White Leghorn cockerels in each lot,

In both experiments the cockerels in Lot I proved to be consistent eaters, never appearing to be hungry, but always eating their feed readily. The cockerels in Lot II were a little better as eaters than were those in Lot I. The cockerels in lots V and VI proved to be fair to good eaters at the beginning, but they had a tendency to slow down toward the end of the experiment. In Experiment I, the cockerels in lots III and IV were good eaters throughout, in fact, they appeared to be more anxious for their feed than any other lots of cockerels in the experiment. In Experiment 2 the cockerels in lots III and IV started out as poor eaters, but as the experiment progressed they took their feed more readily. Other experiments on these same rations will be made. From a study of the table it will be observed that the cockerels that were given semi-solid buttermilk along with the water made better gains, with one exception, than did those that were not given the buttermilk.

TABLE XXII.—EXPERIMENT NO 1 WEIGHT PER DAY FOR EACH LOT IN OUNCES, AND THE TOTAL GAIN FOR EACH LOT IN OUNCES.

May	3	4	5	6	7	8	9	10	11	12	Total gain
Lot 1	136	136	137	139	143	145	145	148	145	147	11 ozs.
Lot 2	136	136	143	144	149	149	152	153	153	156	20 ozs
Lot 3	124	120	120	123	125	128	127	129	129	129	5 ozs.
Lot 4	144	140	143	144	149	151	152	153	152	156	12 ozs
Lot 5	137	135	138	144	145	147	148	149	148	149	12 ozs.
Lot 6	128	127	128	130	135	137	141	129	143	147	19 ozs.

TABLE XXIII.—EXPERIMENT NO. 1. DRY WEIGHT OF FEED IN OUNCES CONSUMED PER DAY BY EACH LOT.

May	3	4	5	6	7	8	9	10	11	Total feed
Lot 1	8	12	12 8	7 3	10 5	11 6	11 6	8	10 8	92 6 ozs.
Lot 2	8	12	11 0	12 0	9 5	11 5	11 6	8 3	11 3	95 2 ozs.
Lot 3	8	12	9 3	14 0	14 0	13 3	14 3	15 0	12 0	111 9 ozs.
Lot 4	8	11 6	12 1	14 0	10 3	9 5	12 6	14 0	12 0	104 1 ozs.
Lot 5	8	12	12 6	10 8	9 6	11 3	11 3	8 6	9 3	93 5 ozs.
Lot 6	8	9 3	9 8	11 1	9 3	12 3	12 0	7 6	10 3	89 7 ozs.

TABLE XXIV.—EXPERIMENT NO 2. WEIGHT PER DAY FOR EACH LOT IN OUNCES AND THE TOTAL GAIN FOR EACH LOT IN OUNCES.

June	6	7	8	9	10	11	12	13	14	15	Total gain
Lot 1	120	124	124	128	128	128	132	132	132	132	12 ozs.
Lot 2	128	128	130	132	136	136	140	144	144	144	16 ozs
Lot 3	112	112	112	112	116	120	120	120	120	124	12 ozs.
Lot 4	120	120	124	124	128	128	128	128	128	132	12 ozs.
Lot 5	116	120	124	124	128	128	128	128	128	128	12 ozs
Lot 6	128	128	128	132	136	136	140	144	144	144	16 ozs

TABLE XXV.—EXPERIMENT NO. 2. DRY WEIGHT OF FEED IN OUNCES CONSUMED PER DAY BY EACH LOT.

June	6	7	8	9	10	11	12	13	14	15	Total feed
Lot 1	6 6	8 0	12 0	10 3	10 0	12 0	10 0	6 3	7 3	7 0	89 5 ozs
Lot 2	8 0	8 0	12 0	14 3	10 6	12 0	11 6	8 0	8 0	8 0	100 5 ozs.
Lot 3	5 3	7 3	11 3	13 3	10 0	11 3	9 0	8 0	8 0	8 0	91 5 ozs.
Lot 4	5 0	8 0	12 0	13 3	11 3	10 6	10 6	8 0	8 0	8 0	94 8 ozs.
Lot 5	6 6	6 6	10 3	11 6	10 0	8 6	7 0	5 0	4 6	4 0	74 3 ozs.
Lot 6	7 3	7 6	11 6	14 3	10 6	9 3	8 6	6 6	4 3	5 3	85 5 ozs.

MISCELLANEOUS

During the year egg scales, Harvard balances, a dissecting microscope, and serum syringes for class and laboratory work have been added to our equipment. One Master incubator, and one 103 incubator have been kindly donated by the manufacturers. These will be used primarily for class work; they are also valuable for experimental work in incubation. Aside from the foregoing, complete fattening, killing, and picking equipment has been added. This special equipment together with the completion of the new poultry yards, and the installation of brooding and rearing equipment, make the work for students in Poultry Husbandry very attractive.